THE FATE OF LAKES IN THE ILLINOIS RIVER VALLEY

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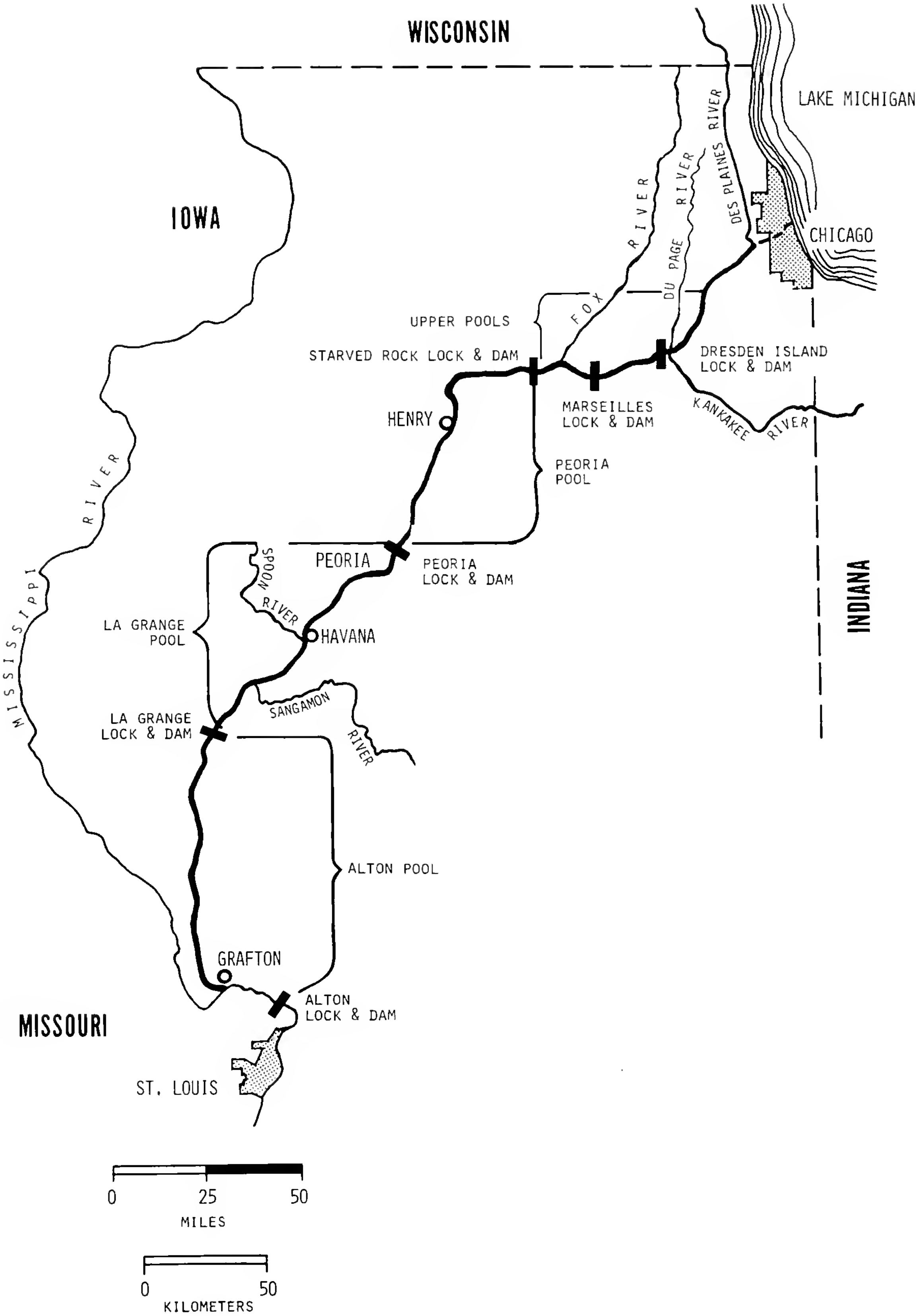

Fig. 1.—The Illinois River valley and its designated navigation pools.

Cover photograph.—Lateral bottomland lakes along the Illinois River channel north of Chillicothe. (Cover design by Mary Beth Kidd.)

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Today, the appearance of the Illinois Valley is a far cry from its appearance in the early 1900's. A glimpse of its near-pristine condition is available in sketchy historical accounts, in old photographs, and in maps prepared by J. W. Woermann between 1902 and 1904 for the U.S. Army Corps of Engineers, Chicago Office. Woermann made wonderfully detailed maps of the river, its lakes, and the floodplain as far back as the valley bluffs.

Using the Woermann maps as a base, we compared the physical nature of the bottomland lakes and the adjacent floodplain of the Illinois Valley in the early 1900's with present conditions and projected our analyses into the early 21st century. This paper is an extension of an earlier report (Bellrose et al. 1979) that evaluated the effect of sedimentation on waterfowl food plants and waterfowl populations.

We examined the status of bottomland water areas because they formed the basis for one of the great inland commercial and sport fisheries as well as for unexcelled waterfowl hunting. Unfortunately for fish and wildlife, the lakes and lesser bottomland water areas have changed drastically in the ensuing 80 years as man has expanded his cultural activities.

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METHODS

The surface areas of the bottomland lakes in the Illinois River valley have been determined a number of times (Mills et al. 1966:5; Lee & Stall 1976; Bellrose et al. 1977:C-3). In this report we have compiled data for the surface areas of the lakes that now exist in the Illinois Valley. We have used the best available sources and field data collected during the summers of 1976–1979. We have also determined the potential surface areas of mud flats and the volume and sedimentation of selected bottomland lakes.

We examined the Illinois River valley by navigation pools: the upper pools, consisting of Dresden Island, Marseilles, and Starved Rock; Peoria Pool; La Grange Pool; and Alton Pool (Fig. 1).

The surface areas of the bottomland lakes were determined from five sources. The first source was the 1902–1904 Woermann maps. The second source was base maps of the Illinois River made by the U.S. Army Corps of Engineers in 1933. These maps were used sparingly because of the landscape changes that have occurred in the valley since their completion. Our third source of information was the aerial photo maps in the 1969 Report for Recreational Development by the Illinois Division of Waterways and Illinois Department of Conservation. The fourth reference used was a series of color aerial photographs taken in 1974 by the Chicago District of the U.S. Army Corps of Engineers. These photographs were not rectified; therefore, the scale of the picture was determined for each lake examined. The fifth source was a map recording soundings of Upper Peoria Lake made by the U.S. Army Corps of Engineers in 1976.

The surface areas of the water bodies on the Woermann maps, the 1969 Recreational Development maps, and the 1974 aerial photographs were measured with a compensating polar planimeter. Surface areas were measured in acres, rounded to the nearest whole unit, and converted to hectares. Data from these measurements were used to evaluate the effects of diverted water, levee districts, and dams on bottomland water areas from 1903 to 1974.

We conducted field work from 1976 to 1979 to determine the volumes of selected bottomland lakes. Because of their sizes and locations, 21 representative bottomland lakes were selected for volume analyses. Eight lakes were studied in Peoria Pool, 11 in La Grange Pool, and 2 in Alton

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This paper is published by authority of the State of Illinois and is a contribution from the Section of Wildlife Research of the Illinois Natural History Survey. Dr. Frank C. Bellrose is a retired Wildlife Specialist and Principal Scientist, Dr. Stephen P. Havera is Associate Wildlife Ecologist, and Fred L. Paveglio, Jr., and Donald W. Steffeck are former Research Assistants in the Section of Wildlife Research.

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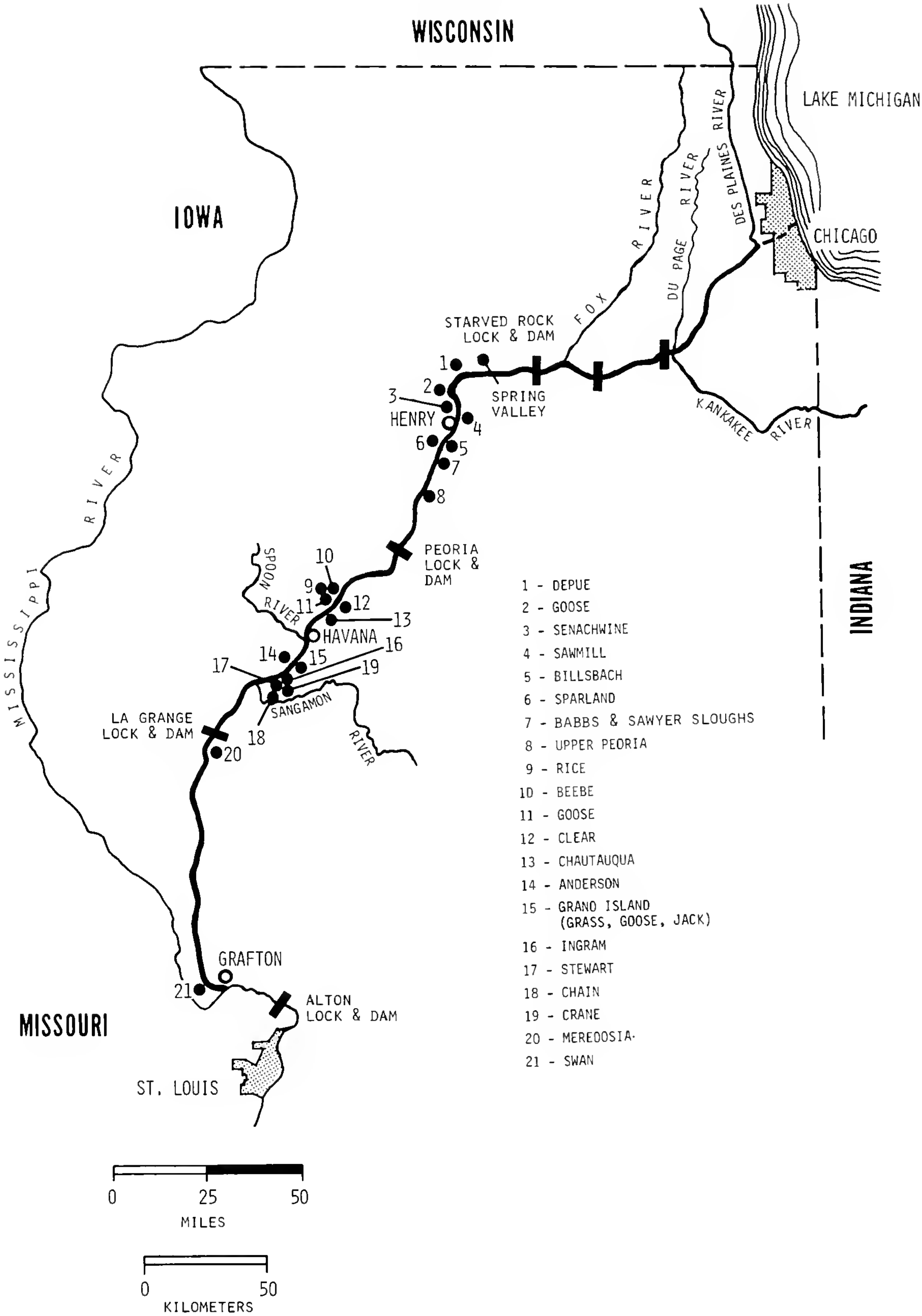

Fig. 2.—Bottomland lakes selected for volume analyses.

Pool (Fig. 2). Lake depths were necessary for volume determinations. Depending on the size and configuration of a lake, between 5 and 12 transects were established across it. Along each transect, depths were taken at intervals of approximately 45–90 m (150–300 feet). To determine bottom elevations, depths recorded at each lake were related to the nearest river gauge reading adjusted for the slope of the river. These transects, with their associated depths, were then transcribed onto photocopies of the 1974 Corps of Engineers aerial photos. The depths of Upper Peoria Lake were taken from the 1976 Corps of Engineers map. Contour lines at 15-cm (6-inch) intervals were drawn onto the photocopies and the 1976 Upper Peoria Lake map. The area within each contour interval was determined by using a compensating polar planimeter. The volume of water in each contour interval was calculated to the nearest acre-foot by multiplying the surface area by the mean depth of the contour interval (Vanoni 1975:375–382). Acre-foot volumes were then converted to cubic meters. The tree line was used as the boundary of these bottomland lakes, because the fluctuation of water levels results in periodic variations in lake areas. Mean sea level (msl) elevations of the tree line were determined by taking from 6 to 12 depth measurements at the tree line of each lake during high water and averaging these readings. The only exception was Upper Peoria Lake, where normal pool elevation was used instead of the tree line. The Peoria Navigation Dam, located a short distance below Peoria Lake, maintains the lake at a fairly constant level, not as evident in other bottomland water areas.

The percentage of surface area and of volume for each contour interval were determined for the selected lakes, and these percentages were totaled by navigation pool for Peoria, La Grange, and Alton pools. The surface areas and volumes were then extrapolated for all bottomland water areas in these pools.

The lakes sampled for depth and volume comprised a total of 17,209 hectares (42,523 surface acres), representing approximately 60 percent of the surface area of bottomland lakes in the Illinois River valley. Therefore, we believe that the findings from our sample of lakes are representative of the surface area, volume, and depth of the lakes in the entire Illinois River valley from 1976 to 1979.

Discrepancies between the surface area of the bottomland lakes measured from the 1969 Recreational Development photos (Table 1) and the surface area derived from field studies for volumetric work (Tables 7–11) resulted from difficulties in obtaining the depths of certain portions of lakes because of access restrictions. For example, Goose (Fulton County), Ingram, Stewart, Chain, and Swan lakes all had portions of their basins that were separated from the principal body of water by low levees; the area of the lakes on Grand Island differs because a small lake separated from the Grass-Goose-Jack chain of lakes could not be reached by boat (Fig. 2).

The average depth for the lakes sampled, the lakes in each of the three pools, and all the bottomland lakes was derived by dividing the volume by the surface area (i.e., cubic meters ÷ hectares = average depth).

Receding water levels expose mud flats between the tree line and the minimum pool. Maximum exposure of mud flats occurs at traditional low-water periods, primarily in July, August, and September, but the area of mud flats exposed varies with navigation pool levels. The percentage of occurrence of various water levels in the Illinois River for the 10 July–1 October growing period, the optimum time of mud flat exposure for moist-soil plant development, was calculated from U.S. Army Corps of Engineers river-stage data for Henry (Peoria Pool) and Havana (La Grange Pool) by determining the mean water level during the growing period for each of the 40 years from 1939 through 1978. The percentage of occurrence of these average water levels for each growing season was calculated for the 40-year period. We examined the relationship between the amount of surface area exposed for mud flats at 15-cm (6-inch) intervals and river levels for the lakes sampled in Peoria and La Grange pools (Fig. 2).

The amount of sedimentation and the sedimentation rate per year for the bottomland lakes were calculated from differences in water depths of the lakes from 1903 to 1979 or other intervals for which data were available.

Findings on certain bottomland lake surface areas, volumes, and water depths by Lee & Stall (1976, 1977) are slightly different from our data for several reasons. Because of fluctuating water levels, water surfaces are ill-defined; and where lakes interconnect, arbitrary delineations of the borders of individual lakes differ. We selected the tree line as the lake margin. Lee & Stall (1976, 1977) used the pool contour level, which was usually below the tree line in elevation. Their parameters reduced the surface areas and water depths of certain lakes in comparison with our data. Lee & Stall (1976, 1977) also included Goose Lake, Upper Peoria Lake, and Lower Peoria Lake in Peoria Lake. We excluded Goose Lake from Upper Peoria Lake and did not study the depth or sedimentation of Lower Peoria Lake. Lee & Stall (1977) selected transects of Upper Peoria Lake that were weighted toward the lower end, where the water was deeper. Moreover, they included the depth of the river channel in determining the depth of Peoria Lake; we excluded channel depths.

Lee & Stall partitioned each lake between transects and combined the averages of each partition for the lake as a whole. We used accumulative 0.5-foot (15-cm) contour intervals for the entire lake. These different techniques also made for slightly varying results.

Of the 15 lakes studied by Lee & Stall (1977:57), 6 were studied in detail and 9 were investigated in "reconnaissance" surveys involving reduced sampling. They studied 7 lakes (including Lower Peoria Lake) that we did not study, we studied 13 lakes that they did not study, and 8 lakes were included in both investigations. We provided Lee & Stall with the 1976 sedimentation data for Lake Chautauqua.

TABLE 1.—Surface areas of lakes existing in Peoria, La Grange, and Alton pools in 1903 and 1969.

Area	River Mile	1903 Surface Area		1969 Surface Area		Percent Change
		Hectares	Acres	Hectares	Acres	
			Peoria Pool			
Ponds, Utica to Spring Valley	230–214	113	279	206	509	+82
Turner Lake	215	158	391	141	348	−11
Lyons Lake	213	7	17	18	43	+157
Depue Lake and Hicks Slough	211	153	378	266	658	+74
Spring Lake	210	77	190	238	589	+209
Coleman Lake	210	57	141	52	129	−9
Round Lake	209.5	2	5	6	15	+200
Lost Lake	209	3	7	3	6	0
Hickory Ridge Lake	208	13	32	24	59	+85
First Bridge Lake	207	10	25	6	15	−40
Goose Pond	204	472	1,166	823	2,034	+74
Senachwine Lake	201	1,070	2,644	1,654	4,086	+54
Siebolt Lake	200	149	368	177	438	+19
Sawmill Lake	197	229	566	282	698	+23
Mud Lake	196	24	59	26	65	+8
Town Lake	195	16	40	27	67	+69
Whitney Lake	195	5	12	7	16	+40
Merdian Slough	194	9	22	19	48	+111
Billsbach Lake	194	153	378	438	1,083	+186
Weis Lake	192	61	151	133	328	+118
Fisher's Slough	191	49	121	147	363	+200
Sparland (Goose) Lake	190	139	343	432	1,068	+211
Wightman Lake	188	79	195	258	638	+227
Sawyer Slough	188	21	52	200	494	+852
Babbs Slough	185	33	82	792	1,956	+2300
Big Meadow Lake	184	50	124	275	679	+450
Partridge Drainage and Levee District	181	54	133	913	2,255	+1591
Goose Lake	178	128	316	832	2,057	+550
Upper Peoria Lake	172	2,586	6,390	3,739	9,239	+45
Lower Peoria Lake	164	665	1,643	1,045	2,582	+57
Beesaw Lake	158	23	57	77	190	+235
Wesley Slough	160	11	27	31	76	+182
Subtotal		6,619	16,354	13,287	32,831	+101
			La Grange Pool			
Larish Lake	157	15	37	7	17	−53
Long and Mud lakes	156	32	79	191	472	+497
Pekin and Worley lakes	155	180	445	290	717	+61
Wood Duck Slough	149	1	2	3	8	+200
Boot Jack Lake	148	29	72	103	254	+255
Kingston Lake	147	21	52	31	76	+48
Ferry Lake	144	4	10	7	16	+75
Spring Lake	137	1,234	3,049	520	1,285	−58
Pond Lily Lake	136	27	67	28	69	+4
Rice-Miserable Lake	136	305	754	611	1,510	+100
Beebe (Big) Lake	136	267	660	553	1,366	+107
Lost Lake	135	19	47	16	39	−16
Goose Lake	134	7	17	333	823	+4657
Clear Lake	132	335	828	782	1,931	+133
Lake Chautauqua	128	237	586	1,523	3,763	+543
Liverpool Lake	128	118	292	75	185	−36
Quiver Lake	123	163	403	112	277	−31
Horseshoe Lake	121	12	30	10	23	−17
Matanzas Bay	116	128	316	194	479	+52
Dierker Lake	114	4	10	3	8	−25
Bath Lake	113	23	57	60	147	+161
Moscow Lake	109	54	133	108	267	+100
Grass Lake	111	46	114	233	575	+407
Goose Lake	110	74	183	117	289	+58
Jack Lake	108	238	588	362	894	+52
Anderson Lake	110	58	143	666	1,645	+1048
Patterson Bay	107	20	49	58	143	+190
Curtis Lake	107	17	42	7	17	−59
Powell Bay	106	18	44	25	63	+39
Mathews Bay	106	6	15	16	39	+167

TABLE 1.—Continued.

Area	River Mile	1903 Surface Area		1969 Surface Area		Percent Change
		Hectares	Acres	Hectares	Acres	
Snicarte Lake	106	11	27	13	33	+18
Camp Lake	106	7	17	12	29	+71
Slim Lake	105	27	67	42	104	+56
Ingram Lake	104	17	42	441	1,089	+2494
Stewart Lake	103	511	1,263	567	1,400	+11
Crane Lake	102	261	645	321	794	+23
Chain Lake	100	32	79	226	559	+606
Pin Oak Lake	101	13	32	22	54	+69
Long Lake	100	16	40	60	149	+275
Hickory Island Slough	100	28	69	29	72	+4
Sangamon Lake	99	11	27	62	152	+464
Barkhausen (Cuba Island)	99	17	42	382	945	+2147
Sanganois area[a]	99	160	395	111	275	−31
Sangamon Bay	96	119	294	105	259	−12
Sugar Creek Lake	95	40	99	75	184	+88
Treadway and Coleman's lakes	93	203	502	325	803	+60
Big Lake	93	67	166	45	111	−33
Little Lake	93	17	42	18	45	+6
Muscooten Bay area	90	361	892	498	1,231	+38
York Lake	87	58	143	159	393	+174
South Beardstown Lake	84	34	84	99	245	+191
Big Prairie area	81	71	175	266	658	+275
Subtotal		5,773	14,266	10,922	26,981	+89
			Alton Pool			
Meredosia Lake	75	422	1,043	601	1,484	+42
Ponds, Meredosia Island	74	110	272	77	190	−30
Barlow Lake	68	14	35	20	49	+43
Smith-Atkinson area	67	99	245	120	297	+21
Allens Lake area	63	17	42	78	192	+359
Jack Ellis Lake	57	8	20	8	19	0
Prairie Lake	56	7	17	9	22	+29
Hurricane Island Slough	27	9	22	5	12	−44
Godars Swamp	26	37	91	55	136	+49
Diamond Island Slough	24	10	25	51	127	+410
Hamilton Lake	23	3	7	5	12	+67
Helmbold Slough	14	3	7	19	48	+533
The Glades	14	185	457	104	256	−44
Fowler Lake	12	24	59	97	240	+304
Deep Lake	11	12	30	18	44	+50
Long Lake	11	31	77	28	68	−10
Upper and Lower Flat lakes	10	21	52	65	160	+210
Stump Lake	9	21	52	223	552	+962
Swan and Fuller lakes	8	187	462	1,163	2,873	+522
Gilbert Lake	5	39	96	94	232	+141
Calhoun Point	3	83	205	351	868	+323
Subtotal		1,342	3,316	3,191	7,881	+137
Total:		*13,734*	*33,936*	*27,400*	*67,693*	*+100*

[a]Water areas in the Sanganois Conservation Area and its immediate vicinity are not delineated separately in this table.

PRISTINE CONDITIONS

Early in the 1900's, the bottomland water areas of the Illinois River were almost pristine even though a surprising amount of forest in the lower valley floodplain had been cleared for cultivation. Water areas of numerous shapes and sizes were scattered along both sides of the Illinois River from Spring Valley to Grafton (Fig. 2). They took the forms of river marshes, long narrow sloughs, oval ponds or small lakes, and lakes of large size that were often ameboid in shape. Those water areas fed by springs or streams maintained continuous outlets to the river, whereas others were separated from the river except during periods of overflow from floods. Although many bottomland water areas were in close proximity to the river, a number were separated from it by broad bands of forest up to 0.8 km (0.5 mile) in width.

In only one area, Chillicothe to Peoria (Peoria Lake), has the Illinois River maintained a channel through an extensive water area. An alluvial fan, created by the entrance of Ten Mile Creek, has pinched this once continuous broad expanse of water into two segments: Upper Peoria Lake and Lower Peoria Lake. Otherwise, all lakes are lateral along the remarkably narrow, straight river channel.

TABLE 2.—The numbers of water areas by size class (in hectares) in three regions of the Illinois Valley in 1903 and 1969 and the percentages leveed and unleveed. Changes in numbers and size class resulted first from diverted water from Lake Michigan and later from navigation dams.

Size Class	Peoria Pool								La Grange Pool								Alton Pool							
	Number				Percent				Number				Percent				Number				Percent			
(Hectares)	1903			1969	1903			1969	1903			1969	1903			1969	1903			1969	1903			1969
	Lev.[a]	Unl.[b]	Both	Unl.	Lev.	Unl	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.	Lev.	Unl.	Both	Unl.
0.1–19.9	2	21	23	14	50.0	45.7	46.0	32.6	46	54	100	18	61.3	56.0	58.5	30.5	65	46	111	15	65.0	80.7	70.7	45.5
20.0–39.9	0	6	6	7		13.0	12.0	16.3	9	16	25	5	12.0	16.7	14.6	8.5	14	7	21	4	14.0	12.3	13.4	12.1
40.0–80.0	0	8	8	3		17.4	16.0	7.0	11	12	23	8	14.7	12.5	13.5	13.6	13	1	14	6	13.0	1.8	8.9	18.2
81.0–161.9	0	6	6	3		13.0	12.0	7.0	4	6	10	8	5.3	6.3	5.8	13.6	5	1	6	4	5.0	1.8	3.8	12.1
162.0–323.9	2	1	3	7	50.0	2.2	6.0	16.3	2	5	7	7	2.7	5.2	4.1	11.9	3	1	4	2	3.0	1.8	2.5	6.1
324.0–647.9	0	1	1	2		2.2	2.0	4.7	1	3	4	10	1.3	3.1	2.3	16.9	0	1	1	1	...	1.8	0.6	3.0
648.0–1,295.0	0	2	2	5		4.4	4.0	11.6	2	0	2	2	2.7	...	1.2	3.4	0	0	0	1	...	...	...	3.0
1,296.0–2,600.0	0	1	1	1		2.2	2.0	2.3	0	0	0	1	0.0	...	...	1.7	0	0	0	0	...	...	...	
2,600 +	0	0	0	1		...	...	2.3	0	0	0	0	0.0	...	...	...	0	0	0	0	...	...	...	...
Total	*4*	*46*	*50*	*43*	*100.0*	*100.1*	*100.0*	*100.1*	*75*	*96*	*171*	*59*	*100.0*	*99.8*	*100.0*	*100.1*	*100*	*57*	*157*	*33*	*100.0*	*100.2*	*99.9*	*100.0*

[a]Lev = Leveed
[b]Unl = Unleveed

We glean a picture of the bottomlands with their lakes, sloughs, and marshes near the beginning of the 20th century from old maps, photographs, and a description by Kofoid (1903:151–155). The waters were much clearer then and were stained more from organic matter than from silt. Descriptions of the lake beds suggest that the bottoms of soft black ooze resulted more from the decay of aquatic and marsh vegetation than from the deposition of silt. The abundance of beds of pondweeds (*Potamogeton* spp.), coontail (*Ceratophyllum demersum*), and waterlilies (*Nymphaea tuberosa*) in many of the lakes attests to waters sufficiently clear to provide these plants adequate light for photosynthesis (Fig. 3). Around the lake margins, emergent vegetation of two or more species of duck potato (*Sagittaria latifolia, S. rigida*), marsh smartweed (*Polygonum coccineum*), river bulrush (*Scirpus fluviatillis*), and other less common species were found in extensive marshes. Kofoid (1903:154) described the now drained Flag Lake as a "sea of rushes." An old map of Senachwine Lake shows extensive beds of wild rice (*Zizania aquatica*); indeed, two water areas were named Rice Lake and Rice Pond, presumably because of the abundance of this plant.

Although there were few large lakes in 1900, scores of small lakes, ponds, and sloughs dotted the floodplain (Table 2). Lakes of notable size were Goose (Bureau County), Senachwine, Peoria, Beebe (Big), Spring (now largely drained), Thompson and its neighbor Flag (both now drained), Crane, Stewart, and Meredosia. Numerous small bodies of water, often linked by winding sloughs, were dispersed through the bottomland forest.

Even without additional water (diverted from Lake Michigan beginning in 1900) to add to the depths of existing lakes, they were deeper than they are now. Some lakes in prediversion times had depths as great as 3.7–4.9 m (12–16 feet), but most were between 1.2 and 1.8 m (4–6 feet). Diverted water in the early 1900's added extensive areas and about a meter to the depths of most water areas.

MAN'S INFLUENCE

Effects of Diverted Water

Water was diverted in appreciable volume from Lake Michigan to the Illinois River when the Sanitary and Ship Canal was opened at Chicago on 1 January 1900 (Fig. 4). However, limited amounts of lake water had entered the river after 1871 through the Illinois and Michigan Canal. Diversion increased steadily until about 1920. Between 1900 and 1938, the average volume of Lake Michigan water diverted into the Illinois River system was 205 cubic meters per second (m^3/s) (7,222 cubic feet per second [ft^3/s]). Since 1939, the volume of diverted water has averaged 91 m^3/s (3,200 ft^3/s).

Diverted water increased low midsummer river levels by as much as 2.1 m (7 feet) (Fig. 4) at Havana. This diversion resulted in a deepening and an extension of all water areas. Many water areas previously separated by stands of bottomland timber merged into larger bodies of water. Thousands of acres of trees, including numerous pin oak (*Quercus palustris*) and pecan (*Carya illinoensis*) stands

Fig 3.—Quiver Lake in 1894 contained luxuriant beds of submerged aquatic plants, as is evident in this view. Resuspensions of bottom sediments eliminated aquatic plants from this lake after 1940.

that produced mast for a variety of wildlife, died from inundation. As a consequence, current maps may label a single water body with several names, reflecting the early 1900's when the water areas were distinct entities.

Navigation dams completed in 1933 on the upper river above Utica had a profound effect upon this reach, which has a narrow floodplain and a rapid fall (Bellrose et al. 1977). The Peoria and La Grange dams, completed in 1938, had less effect on the middle portion of the river. The Alton Dam, operational in 1938, appreciably raised water levels and enlarged the surface area of bottomland water bodies below Pearl. In the lower one-third of the pools, the dams have maintained slightly higher minimum water levels than those under maximum diversion rates. However, about midway up the pools, river levels become slightly lower than they were during peak diversion (Fig. 4).

The merging water bodies and their enlargement, first by diverted water and later by navigation dams, are reflected by the reduction in numbers of water bodies and a corresponding increase in total water area between 1903 and 1969 (Table 2). A comparison of the frequency of occurrence by size-class of water areas in the unleveed areas of the Illinois Valley in 1903 and in 1969 reveals the effect of increased river levels. The number of water areas in 1903 had declined 64 percent by 1969—from 378 bodies to 135 as they merged to enlarge the predominant water areas (Table 2). The enlargement of most existing water areas was considerable. The surface water area in the

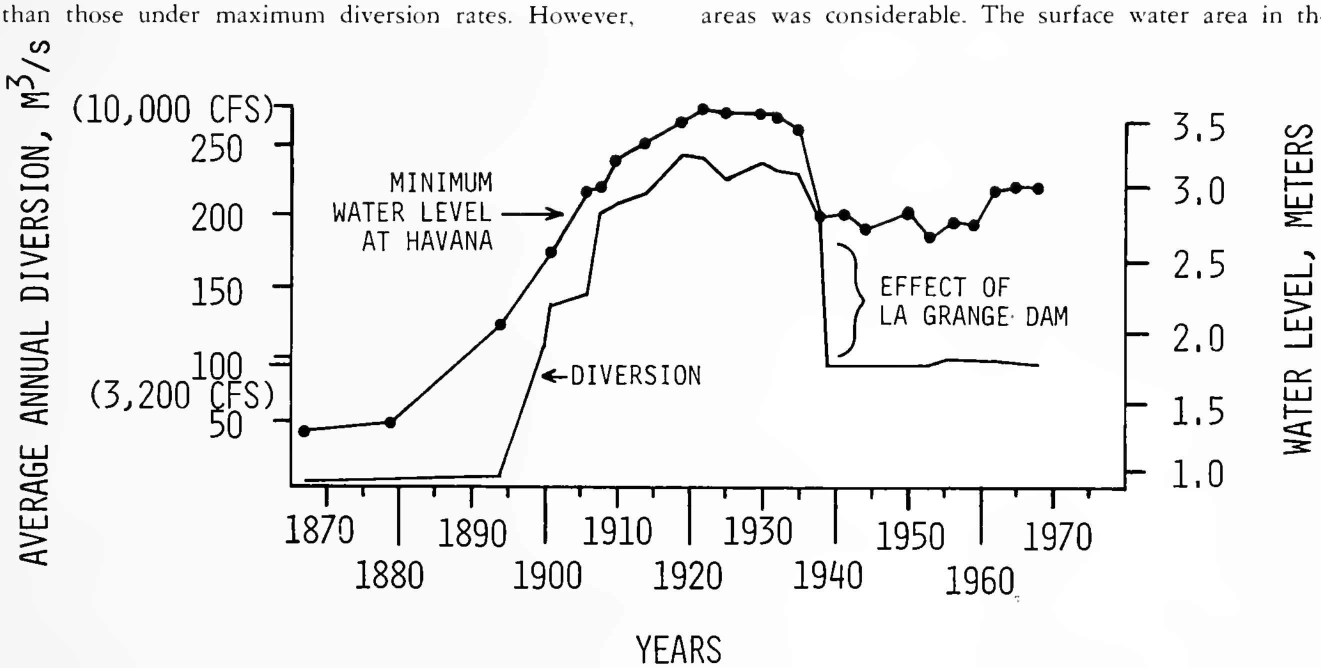

Fig 4.—Average annual amounts of Lake Michigan water diverted into the Illinois River from 1865 to 1968 and corresponding river levels at Havana, Illinois (after Starrett 1972:147).

Illinois Valley approximately doubled as a result of the increase in river levels from diverted water, navigation dams, or both (Table 1).

Effects of Drainage and Levee Districts

During the early period of water diversion from Lake Michigan, drainage and levee districts were organized to convert large sections of the Illinois Valley into farmland. Although a few small districts in the higher floodplain were organized prior to 1900, those most strongly influencing the floodplain were formed between 1909 and 1922 (Mulvihill & Cornish 1929:38).

The sizes of drainage and levee districts and their water surfaces in 1903 prior to drainage are shown in Table 3. By the time these districts were formed, their water surfaces had approximately doubled because of the diverted water from Lake Michigan. Peoria Pool lost little of its water area to drainage with the formation of only two districts, one of which was abandoned in 1926.

Because of diverted water, the water surface lost through the drainage of lakes, sloughs, ponds, and marshes in the levee districts of La Grange Pool was almost twice the 5,508 ha (13,610 acres) present in 1903 (Table 3). The water bodies drained were, therefore, comparable in area to the current 10,922 ha (26,981 acres) of backwater lakes remaining in this region of the valley (Table 1).

Fig. 5 shows the effect of drainage and levees on the floodplain of the Illinois River above Havana. Several drainage and levee districts were formed, 1910–1920, to drain lakes on the west side of the river. However, on the east side of the river, levees of the defunct Chautauqua District were used to create a larger body of water where once numerous smaller lakes had occurred: Duck, Dennis, Grass, Goose, Libarger, and Widgeon.

Table 3.—Organized drainage and levee districts in the Illinois River valley extant in 1920 and their water surfaces in 1903 prior to drainage.

Navigation Pool	Drainage and Levee Districts			1903	
	Name	County	Ha[a]	Water Surface (Ha)	Percent in Water
Peoria	Hennepin	Putnam	1,044	377	36.1
	Partridge	Woodford-Marshall	1,175	54	4.6
Subtotal			2,219	431	19.4
La Grange	Pekin and La Marsh	Peoria	1,066	24	2.3
	Rocky Ford	Tazewell	594	99	16.7
	Spring Lake	Tazewell	4,775	1,234	25.8
	Banner Special	Fulton-Peoria	1,848	258	14.0
	East Liverpool	Fulton	1,083	156	14.4
	Liverpool	Fulton	1,231	231	18.8
	Chautauqua	Mason	1,460	237	16.2
	Thompson Lake	Fulton	2,118	1,086	51.3
	West Matanzas and others	Fulton	4,282	186	4.3
	Big Lake	Schuyler	1,307	208	15.9
	Kelley Lake	Schuyler	399	21	5.3
	Lost Creek	Cass	1,109	2	0.1
	Coal Creek	Schuyler	2,588	95	3.7
	Crane Creek	Schuyler	2,030	102	5.0
	Big Prairie	Brown	731	71	9.7
	Valley	Cass	1,222	0	0.0
	South Beardstown	Cass	2,773	1,498	54.0
Subtotal			30,616	5,508	18.0
Alton	Meredosia Lake	Morgan-Cass	1,517	76	5.0
	Willow Creek	Morgan	1,738	38	2.2
	Little Creek	Brown	652	26	4.0
	McGee Creek	Pike-Brown	4,363	268	6.1
	Coon Run	Scott-Morgan	1,765	0	0.0
	Mauvais Terre	Scott	1,036	45	4.3
	Valley City	Pike	1,812	157	8.7
	Scott County	Scott	4,116	228	5.5
	Big Swan	Scott	5,159	396	7.7
	Hillview	Greene-Scott	4,987	801	16.1
	Hartwell	Greene	3,524	158	4.5
	Keach	Greene	3,194	328	10.3
	Eldred	Greene	3,415	87	2.5
	Spankey	Greene	324	16	4.9
	Nutwood	Greene-Jersey	4,297	229	5.3
Subtotal			41,929	2,853	6.8
Total			74,764	8,792	*11.8*

[a]Drainage and levee district hectares taken from Dickerson (197[illegible]).

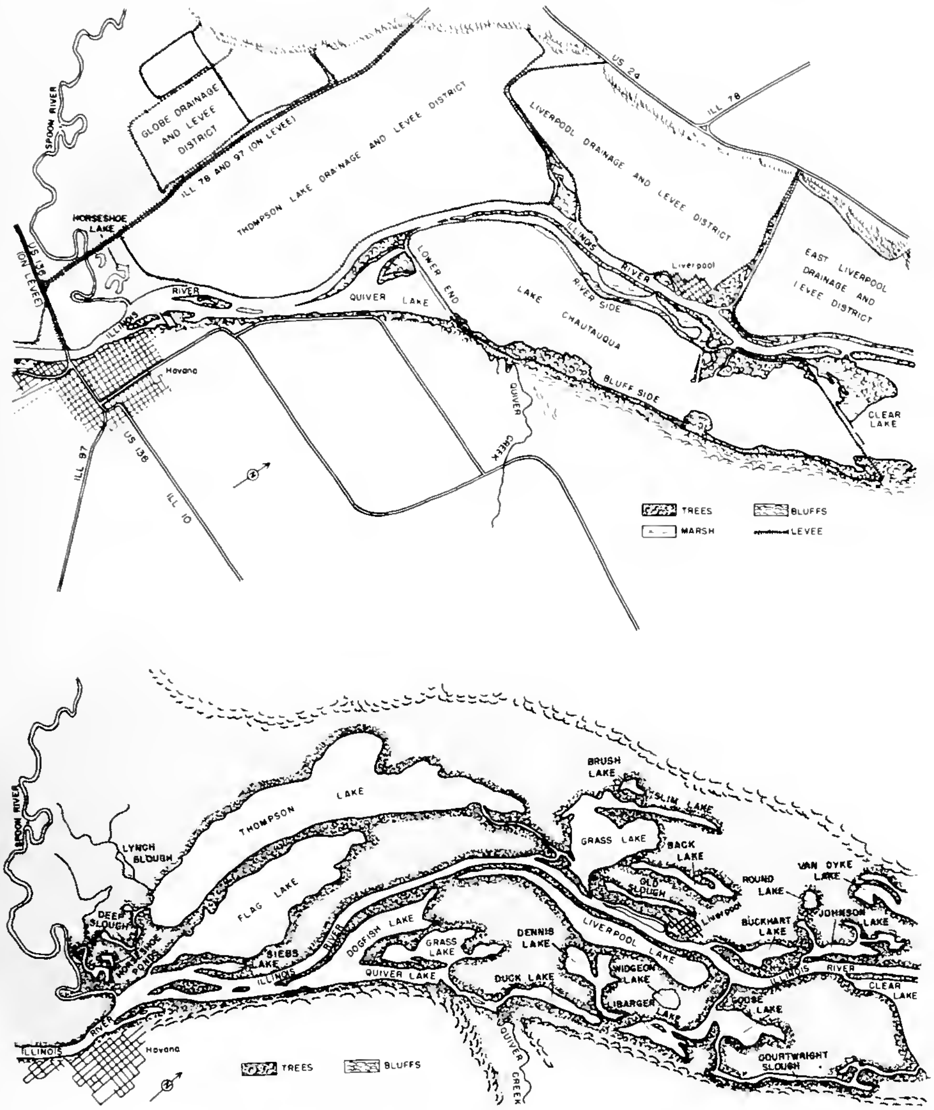

Fig. 5.—The Illinois River floodplain above Havana, Illinois, (top) as it appears now and (bottom) as it appeared before 1912. Note the elimination of natural lakes by drainage and levee districts (after Mills et al. 1966).

In the Alton Pool region of the Illinois Valley, about 2,853 ha (7,050 acres) of bottomland water areas existed in the levee districts prior to 1900 (Table 3). With diverted water increasing the surface area 137 percent (Table 1), there were 6,762 ha (16,709 acres) in the early 1900's. Today, there are 3,191 ha (7,881 acres) (Table 1). The area of bottomland lakes in Alton Pool of the Illinois River was reduced 53 percent by drainage and levee districts, representing a larger proportion of the floodplain than drainage districts represent in other pools.

An overall appraisal of the changing water area of bottomlands in the Illinois Valley between Utica and Grafton indicates that under pristine conditions there were 22,526 ha (55,662 acres) of ponds, sloughs, lakes, and marshes (Tables 1, 3). With the addition of diverted water, the surface area essentially doubled to a calculated 45,052 ha (111,323 acres), but in the next 20 years declined to about 27,400 ha (67,693 acres), as drainage and levee districts encroached upon the floodplain (Table 1).

Under pristine conditions, a few large and a multitude of small, dispersed water areas occurred in the lower 112 km (70 miles) of the valley as far up as Meredosia (Fig. 2). Above Meredosia, bottomland lakes were generally larger. As one proceeded upstream to La Salle, water areas occupied an increasing proportion of the 134,763-ha (333,000-acre) floodplain. The small dispersed water areas below Meredosia are probably attributable to the sedimentation resulting from the backing action of the Mississippi River on the Illinois River during flood times over the 12,000 years since the melt of the Wisconsin glaciation.

According to Mulvihill & Cornish (1929:37), in 1929 1 drainage and levee district occupied 4.9 percent of the 21,449-ha (53,000-acre) bottomland subject to overflow between La Salle and Peoria, 9 drainage and levee districts covered 72.5 percent of the 20,639-ha (51,000-acre) bottomland between Peoria and Havana, 9 districts embraced 30.5 percent of the 25,496-ha (63,000-acre) bottomland subject to overflow between Havana and Beardstown, and 19

districts contained 78.3 percent of the 67,179-ha (166,000-acre) floodplain between Beardstown and Grafton. Therefore, in 1929 a total of 38 drainage and levee districts occupied 56.4 percent (76,063 ha or 187,952 acres) of the total 134, 763 ha (333,000 acres) from La Salle to Grafton.

After all of the drainage and levee districts were established, changes occurred in the status of five districts (Table 4). The Partridge District, above Peoria, was abandoned in 1926. With subsequent reflooding, it has been acquired by several private duck clubs. The Rocky Ford Drainage and Levee District, near Pekin, was purchased by Commonwealth Edison Company and was converted into a cooling lake for its Powerton Station in 1971–1972.

Because of a court verdict, a remnant of Spring Lake was declared navigable, and therefore, was not drained. A 300-ha (741-acre) area was isolated by an internal levee from the remainder of the bottomland that was drained. In 1958, the Illinois Department of Conservation raised the water level 0.9 m (3 feet), increasing the size of Spring Lake to 520 ha (1,285 acres).

The Chautauqua Drainage and Levee District above Havana was flooded during the fall of 1926 and was subsequently abandoned. It has been a national wildlife refuge since 1936. The levees that once excluded water now retain it to form a larger water area than occurred prior to drainage (Table 4). The Big Prairie District discontinued levee maintenance in 1934, and water bodies therein returned to their earlier sizes.

By impinging on the floodplain of the Illinois River, the drainage and levee districts have "reduced the space available for flow and for storage, which has the effect of increasing flood stages" (Mulvihill & Cornish 1929:37). Walraven (1950:39) has pointed out that with nearly identical stream flows of 3,257 m^3/s (115,000 ft^3/s) at Beardstown in 1904 and 1943, the river was 3 m (9.7 feet) higher in 1943. He attributed the reduction in the floodplain by levees as the cause for the increase in river level with the same rate of discharge.

During the 1943 flood, several levees broke, resulting in the inundation of over 22,000 ha (54,400 acres) of bottomland. As a consequence, the flood crest was appreciably lowered, and Walraven (1950:39) concluded that levees had "raised the high water mark at Beardstown by more than ten feet." He calculated (1950:40) that to lower the flood crest 0.3 m (1 foot) would require a reduction in flow of 96 m^3/s (3,400 ft^3/s) at Kingston Mines, 188 m^3/s (6,650 ft^3/s) at Beardstown, and 227 m^3/s (8,000 ft^3/s) at Meredosia.

To reduce flood heights when critical river stages were reached, Walraven (1950:70–74) proposed using certain drainage and levee districts for storage of flood waters. At other times shallow lakes would be maintained within the districts for fish, wildlife, and outdoor recreation.

TABLE 4.—Water area before the creation and after the abandonment or partial reflooding of drainage and levee districts.

Navigation Pool	District	Water Surface in Hectares: Before Diversion 1900	Before Drainage 1902–1922	1969
Peoria	Partridge[a]	54	913	913
La Grange	Rocky Ford[b]	99	200	577[c]
	Spring Lake[d]	1,234	1,533	520
	Chautauqua[e]	237	540	1,523
	Big Prairie[f]	71	266	266

[a]Partridge district was reflooded in 1926.

[b]Rocky Ford district was converted to a power plant cooling lake, 1971–1972.

[c]This area differs slightly from the area in Table 3.

[d]The remnant of Spring Lake (Tazewell County) was increased by the Illinois Department of Conservation in 1958.

[e]Chautauqua district was flooded in 1926; its acquisition for a national wildlife refuge was started in 1936.

[f]Big Prairie district levees were abandoned in 1934; the district was later reflooded.

TABLE 5.—Change in the surface area (in hectares) of water in the Illinois River valley as a result of navigation pools created by dams.[a]

Navigation Pool	Main Channel Border, Lakes, Sloughs, Ponds: Pre[b]	Post	Marsh: Pre	Post	Combined: Pre	Post
Dresden Island	392	857	0	59	392	916
Marseilles	189	398	186	4	375	402
Starved Rock	174	834	0	0	174	834
Peoria	11,592	12,376	4,037	1,004	15,629	13,380
La Grange	8,967	10,378	3,125	1,082	12,092	11,460
Alton	3,157	4,490	1,055	927	4,212	5,417
Total	*24,471*	*29,333*	*8,403*	*3,076*	*32,874*	*32,409*

[a]Data for all navigation pools except Alton are from Bellrose et al. (1977:C-3, Table C-1). Data for Alton Navigation Pool in the lower Illinois River valley are from U.S. Army Corps of Engineers 1979.

[b]Preimpoundment prior to 1933. Postimpoundment after 1933 in the Dresden, Marseilles, and Starved Rock pools; after 1939 in Peoria, La Grange, and Alton pools.

Effects of Navigation Dams

The creation of a 2.7-m (9-foot) waterway, resulting largely from dams constructed in the Illinois River by the

TABLE 6.—Surface areas of bottomland lakes between Chicago and Starved Rock Lock and Dam (upper pools).

Bottomland Lake	River Mile	Hectares	Acres
Dresden Island Pool			
Jackson Creek Lake	278	3	7
Lake	277	12	30
Kankakee River Lake	273	8	20
Dresden Island Dam Impoundment	272	196	484
Total		219	541
Marseilles Pool			
Aux Sable Lake	270	31	77
Negro Slough	268	4	10
Peacock Slough	265	5	12
Moody Bayou	254	4	10
McNellis Bayou	252	12	30
Total		56	139
Starved Rock Pool			
Lake	233	46	114
Starved Rock Dam Impoundment	233	875	2,162
Total		921	2,276
Grand total for upper pools		*1,196*	*2,956*

TABLE 7.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depths of selected bottomland lakes in Peoria Pool (above Peoria Lake), 1978

Water Depth[a]			Depue Lake				Goose Lake (Putnam County)				Senachwine Lake			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
441.5	Tree line													
441.0	0.15	0.5	38	94	29,592	24	180	444	136,863	111	171	423	130,698	106
440.5	0.30	1.0	35	87	80,145	65	186	459	424,152	344	85	210	194,814	158
440.0	0.46	1.5	33	81	125,766	102	242	597	919,818	746	123	305	469,773	381
439.5	0.61	2.0	26	64	138,096	112	214	529	1,142,991	927	156	386	832,275	675
439.0	0.76	2.5	27	66	181,251	147	1	3	7,398	6	256	632	1,754,559	1,423
438.5	0.91	3.0	32	78	263,862	214	1	2	4,932	4	658	1,627	5,516,442	1,474
438.0	1.07	3.5	16	40	161,523	131		...	...		174	430	1,724,967	1,399
437.5	1.22	4.0	21	52	242,901	197			...		30	73	339,075	275
437.0	1.37	4.5	14	35	186,183	151								...
436.5	1.52	5.0	11	28	161,523	131		...			...		...	...
436.0	1.68	5.5	10	25	160,290	130	...	...						
435.5	1.83	6.0	3	8	54,252	44	...						...	...
Total			*266*	*658*	*1,785,384*	*1,448*	*824*	*2,034*	*2,636,154*	*2,138*	*1,653*	*4,086*	*10,962,603*	*8,891*
Average depth[b]			0.67 m, 2.2 feet				0.32 m, 1.1 feet				0.66 m, 2.2 feet			

TABLE 7.—Continued.

Water Depth[a]			Sawmill Lake				Billsbach Lake				Sparland Lake			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
441.5	Tree line													
441.0	0.15	0.5	70	172	53,019	43	66	164	50,553	41	106	262	80,762	66
440.5	0.30	1.0	23	57	53,019	43	47	116	107,271	87	45	111	102,709	83
440.0	0.46	1.5	44	108	166,455	135	48	119	183,717	149	68	167	257,820	209
439.5	0.61	2.0	42	103	220,707	179	96	238	512,928	416	138	342	738,814	599
439.0	0.76	2.5	51	125	345,240	280	92	228	632,529	513	38	93	257,697	209
438.5	0.91	3.0	9	22	76,446	62	42	103	350,172	284	31	76	258,683	210
438.0	1.07	3.5	2	5	19,728	16	15	36	143,028	116	6	16	63,376	51
437.5	1.22	4.0	7	17	80,145	65	14	35	162,756	132			...	...
437.0	1.37	4.5	18	45	236,736	192	9	23	122,067	99			...	...
436.5	1.52	5.0	8	20	117,135	95	7	17	98,640	80			...	...
436.0	1.68	5.5	10	24	155,358	126	2	4	23,427	19	...		...	...
435.5	1.83	6.0			...	...	...	...	...	...	...			...
Total			*284*	*698*	*1,523,988*	*1,236*	*438*	*1,083*	*2,387,088*	*1,936*	*432*	*1,067*	*1,759,861*	*1,427*
Average depth[b]			0.54 m, 1.8 feet				0.55 m, 1.8 feet				0.41 m, 1.3 ft			

TABLE 7.—Continued

Water Depth[a]			Babbs Slough & Sawyer Slough				Total				Percent of Total	
			Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
441.5	Tree line											
441.0	0.15	0.5	236	583	180,018	146	867	2,143	661,505	537	17.7	2.6
440.5	0.30	1.0	97	240	221,940	180	518	1,280	1,184,050	960	10.6	4.6
440.0	0.46	1.5	127	313	483,336	392	684	1,691	2,606,685	2,114	14.0	10.2
439.5	0.61	2.0	241	596	1,286,019	1,043	913	2,257	4,871,830	3,951	18.7	19.1
439.0	0.76	2.5	167	412	1,141,758	926	630	1,557	4,320,432	3,504	12.9	17.0
438.5	0.91	3.0	85	211	716,373	581	858	2,120	7,186,910	5,829	17.6	28.2
438.0	1.07	3.5	19	46	184,950	150	232	573	2,297,572	1,863	4.8	9.0
437.5	1.22	4.0	16	40	183,717	149	88	218	1,008,594	818	1.8	4.0
437.0	1.37	4.5	4	9	48,087	39	46	113	593,073	481	0.9	2.3
436.5	1.52	5.0	...	...	...	...	26	64	377,298	306	0.5	1.5
436.0	1.68	5.5	...	...	...	...	21	52	339,075	275	0.4	1.3
435.5	1.83	6.0		...	...		3	8	54,252	44	0.1	0.2
Total			*993*	*2,450*	*4,446,198*	*3,606*	*4,886*	*12,076*	*25,501,276*	*20,682*	*100.0*	*100.0*
Average depth[b]			0.45 m, 1.5 feet				0.52 m, 1.7 feet					

[a]Gauge readings in mean sea level at Henry, Illinois

[b]Volume ÷ surface area

TABLE 8.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below normal pool elevation and average depth of Upper Peoria Lake in 1976.

Water Depth[a]			Upper Peoria Lake				Percent of Total	
			Surface Area		Volume		Surface Area	Volume
msl	m	ft	ha	a	m³	a-ft		
440.0	Normal pool elevation							
439.5	0.15	0.5	78	192	59,184	48	1.8	0.2
439.0	0.30	1.0	96	238	219,474	178	2.3	0.6
438.5	0.46	1.5	139	343	528,957	429	3.2	1.3
438.0	0.61	2.0	187	463	999,963	811	4.4	2.5
437.5	0.76	2.5	693	1,714	4,753,215	3,855	16.2	12.1
437.0	0.91	3.0	597	1,474	4,998,582	4,054	14.0	12.7
436.5	1.07	3.5	855	2,113	8,467,011	6,867	20.0	21.5
436.0	1.22	4.0	546	1,350	6,240,213	5,061	12.8	15.8
435.5	1.37	4.5	392	969	5,077,494	4,118	9.2	12.9
435.0	1.52	5.0	147	364	2,133,090	1,730	3.5	5.4
434.0	1.83	6.0	193	477	3,234,159	2,623	4.5	8.2
433.0	2.13	7.0	54	133	1,064,079	863	1.3	2.7
432.0	2.44	8.0	32	79	727,470	590	0.7	1.9
431.0	2.74	9.0	34	85	887,760	720	0.8	2.3
Channel[b]	2.74+	9.0+	232	574	...	...	5.4	...
Total			*4,044*	*9,994*	*39,390,651*	*31,947*	*100.1*	*100.1*
Total + channel			4,275	10,568				
Average depth[c]				0.98 m, 3.2 feet				

[a]Gauge reading in mean sea level at Peoria, Illinois.

[b]Channel not included in total volume.

[c]Volume ÷ surface area.

TABLE 9.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depths of selected bottomland lakes in La Grange Pool, 1976–1978.

Water Depth[a]			Rice Lake				Beebe Lake				Goose Lake (Fulton County)			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
434.4	Tree line													
433.9	0.15	0.5	85	209	64,116	52	98	243	75,213	61	47	116	35,757	29
433.4	0.30	1.0	21	52	48,087	39	68	168	155,358	126	18	44	40,689	33
432.9	0.46	1.5	28	69	106,038	86	119	294	452,511	367	28	68	103,572	84
432.4	0.61	2.0	36	88	191,115	155	149	367	790,353	641	55	136	292,221	237
431.9	0.76	2.5	50	124	342,774	278	111	274	759,528	616	49	120	331,677	269
431.4	0.91	3.0	143	353	1,197,243	971	7	17	56,718	46	...	...	...	...
430.9	1.07	3.5	193	478	1,916,082	1,554	1	3	13,563	11	...	...	...	...
430.4	1.22	4.0	56	138	638,694	518	1	1	3,699	3	...	...	...	...
429.9	1.37	4.5	...	...	...	...	...	...	...	...	...	...	...	...
Total			*612*	*1,511*	*4,502,149*	*3,653*	*554*	*1,367*	*2,306,943*	*1,871*	*197*	*484*	*803,916*	*652*
Average depth[b]			0.74 m, 2.4 feet				0.42 m, 1.4 feet				0.41 m, 1.3 feet			

TABLE 9.—Continued

Water Depth[a]			Clear Lake				Lake Chautauqua				Anderson Lake			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
434.4	Tree line													
433.9	0.15	0.5	103	254	77,679	63	203	502	155,358	126	78	193	59,184	48
433.4	0.30	1.0	53	130	120,834	98	200	493	456,210	370	43	107	98,640	80
432.9	0.46	1.5	62	154	237,969	193	212	525	810,081	657	40	99	152,892	124
432.4	0.61	2.0	98	243	524,025	425	504	1,246	2,689,173	2,181	57	141	304,551	247
431.9	0.76	2.5	100	248	686,781	557	339	837	2,322,972	1,884	86	213	590,607	479
431.4	0.91	3.0	169	417	1,413,018	1,146	64	159	537,588	436	100	247	835,974	678
430.9	1.07	3.5	141	349	1,399,455	1,135	...	...	...	...	123	303	1,215,738	986
430.4	1.22	4.0	55	137	632,529	513	...	...	...	...	136	335	1,549,881	1,257
429.9	1.37	4.5	...	...	...	...	...	...	...	...	3	7	34,524	28
Total			*781*	*1,932*	*5,092,290*	*4,130*	*1,522*	*3,762*	*6,971,382*	*5,654*	*666*	*1,645*	*4,841,991*	*3,927*
Average depth[b]			0.65 m, 2.1 feet				0.46 m, 1.5 feet				0.73 m, 2.4 feet			

TABLE 9.—Continued.

Water Depth[a]			Chain Lake				Crane Lake				Grand Island			
			Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft
434.4	Tree line													
433.9	0.15	0.5	24	60	18,495	15	34	84	25,893	21	139	343	106,038	86
433.4	0.30	1.0	20	49	45,621	37	41	102	93,708	76	59	147	135,630	110
432.9	0.46	1.5	16	39	60,417	49	59	146	225,639	183	50	123	189,882	154
432.4	0.61	2.0	61	150	323,046	262	87	215	463,608	376	210	520	1,122,030	910
431.9	0.76	2.5	62	154	426,618	346	38	94	260,163	211	166	409	1,135,593	921
431.4	0.91	3.0	43	107	363,735	295	28	69	233,037	189	24	59	200,979	163
430.9	1.07	3.5	...	...	...	...	26	63	253,998	206	38	93	372,366	302
430.4	1.22	4.0	...	...	...	...	8	19	88,776	72	9	22	99,873	81
429.9	1.37	4.5	...	...	...	...	1	2	11,097	9		...	...	...
Total			*226*	*559*	*1,237,932*	*1,004*	*322*	*794*	*1,655,919*	*1,343*	*695*	*1,716*	*3,362,391*	*2,727*
Average depth[b]			0.55 m, 1.8 feet				0.51 m, 1.7 feet				0.48 m, 1.6 feet			

TABLE 9.—Continued.

Water Depth[a]			Ingram & Stewart Lakes				Total				Percent of Total	
			Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
msl	m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
434.4	Tree line											
433.9	0.15	0.5	143	355	109,737	89	955	2,360	727,470	590	14.8	2.1
433.4	0.30	1.0	138	341	315,648	256	660	1,632	1,510,425	1,225	10.3	4.4
432.9	0.46	1.5	168	416	641,160	520	782	1,932	2,980,161	2,417	12.1	8.6
432.4	0.61	2.0	141	348	750,897	609	1,398	3,454	7,451,019	6,043	21.7	21.5
431.9	0.76	2.5	205	506	1,403,154	1,138	1,205	2,978	8,259,867	6,699	18.7	23.8
431.4	0.91	3.0	78	193	653,490	530	655	1,619	5,491,782	4,454	10.2	15.9
430.9	1.07	3.5	...	...	...	...	522	1,290	5,171,202	4,194	8.1	14.9
430.4	1.22	4.0	...	...	...	...	264	652	3,013,452	2,444	4.1	8.7
429.9	1.37	4.5	...	...	...	...	4	9	45,621	37	0.1	0.1
Total			*873*	*2,159*	*3,874,086*	*3,142*	*6,445*	*15,926*	*34,650,999*	*28,103*	*100.1*	*100.0*
Average depth[b]			0.44 m, 1.5 feet				0.54 m, 1.8 feet					

[a] Gauge reading in mean sea level at Havana, Illinois

[b] Volume ÷ surface area

TABLE 10.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depth of Meredosia and Swan and Flat lakes in Alton Pool, 1978.

Water Depth		Meredosia Lake				Swan and Flat Lakes				Total				Percent of Total	
		Surface Area		Volume		Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
m	ft	ha	a	m³	a-ft	ha	a	m³	a-ft	ha	a	m³	a-ft		
0.0	Tree line														
0.15	0.5	82	202	61,650	50	89	221	67,815	55	171	422	129,465	105	10.7	1.3
0.30	1.0	66	163	150,426	122	83	206	191,115	155	149	369	341,541	277	9.3	3.5
0.46	1.5	74	183	282,357	229	82	202	311,949	253	156	385	594,306	482	9.7	6.1
0.61	2.0	64	159	342,774	278	163	403	870,498	706	227	562	1,213,272	984	14.2	12.4
0.76	2.5	68	167	462,375	375	265	655	1,817,442	1,474	333	822	2,279,817	1,849	20.8	23.3
0.91	3.0	106	261	879,129	713	236	582	1,974,033	1,601	341	843	2,853,162	2,314	21.3	29.2
1.07	3.5	58	144	575,811	467	75	185	741,033	601	133	328	1,316,844	1,068	8.3	13.4
1.22	4.0	69	171	790,353	641	7	18	85,077	69	76	189	875,430	710	4.8	8.9
1.37	4.5	7	17	91,242	74	...	...	...	...	7	17	91,242	74	0.4	0.9
1.52	5.0	6	14	81,378	66	...	...	...	...	6	14	81,378	66	0.4	0.8
1.68	5.5	2	4	25,893	21	...	...	...	...	2	4	25,893	21	0.1	0.3
Total		*602*	*1,485*	*3,743,388*	*3,036*	*1,000*	*2,472*	*6,058,962*	*4,914*	*1,601*	*3,955*	*9,802,350*	*7,950*	*100.0*	*100.1*
Average depth[a]		0.62 m, 2.0 feet				0.61 m, 2.0 feet				0.61 m, 2.0 feet					

[a] Volume ÷ surface area

TABLE 11.—Surface areas and volumes at 0.15-m (0.5-foot) contour intervals below the tree line and average depth of bottomland lakes in the entire Illinois River valley, Utica to Grafton, Illinois, 1976–1978

Water Depth		Peoria Pool, Excluding Peoria Lake				Peoria Lake (Upper & Lower)				La Grange Pool			
		Surface Area		Volume		Surface Area		Volume		Surface Area		Volume	
m	ft	ha	a	m^3	a-ft	ha	a	m^3	a-ft	ha	a	m^3	a-ft
0.0	Tree line												
0.15	0.5	1,363	3,367	1,038,186	842	102	253	77,679	63	1,618	3,998	1,233,000	1,000
0.30	1.0	814	2,012	1,860,597	1,509	126	312	288,522	234	1,119	2,765	2,557,242	2,074
0.46	1.5	1,075	2,657	4,094,793	3,321	182	450	692,946	562	1,325	3,273	5,044,203	4,091
0.61	2.0	1,435	3,547	7,653,231	6,207	246	609	1,314,378	1,066	2,368	5,852	12,627,153	10,241
0.76	2.5	991	2,448	6,791,364	5,508	911	2,251	6,243,912	5,064	2,042	5,045	13,997,016	11,352
0.91	3.0	1,348	3,332	11,299,212	9,164	783	1,936	6,564,492	5,324	1,110	2,744	9,304,218	7,546
1.07	3.5	365	901	3,612,690	2,930	1,123	2,775	11,121,660	9,020	884	2,185	8,757,999	7,103
1.22	4.0	139	344	1,588,104	1,288	717	1,772	8,193,285	6,645	447	1,104	5,102,154	4,138
1.37	4.5	72	177	924,750	750	515	1,273	6,668,064	5,408	6	14	70,281	57
1.52	5.0	40	101	589,374	478	194	479	2,803,842	2,274	...		...	...
1.68	5.5	33	82	527,724	428	253	626	4,245,218	3,443	...	...	...	...
1.83	6.0	4	11	81,378	66	...	...	...	...	...		...	...
2.13	6.5	...	...	...	...	71	175	1,401,921	1,137			...	...
2.44	7.0	...	...	...	...	...	...	...	...	...	...	...	...
2.74	7.5	...	...	...	...	42	103	949,410	770			...	...
2.74 + channel	8.0	...	...	...		...	...	...	...	...	...	...	...
	8.5	...	...	...	...	45	111	1,163,952	944			...	...
	9.0	...	...	...		...		...	...		...	...	...
	9.0 + channel	...	...	...	...	305	754	...	...		...	...	...
Total		*7,680*	*18,979*	*40,061,403*	*32,491*	*5,615*	*13,879*	*51,729,282*	*41,954*	*10,919*	*26,980*	*58,693,266*	*47,602*
Average depth[a]		0.52 m, 1.7 feet				0.97 m, 3.2 feet				0.55 m, 1.8 feet			

TABLE 11.—Continued

Water Depth		Alton Pool (La Grange to Grafton)				Total				Percent of Total	
		Surface Area		Volume		Surface Area		Volume		Surface Area	Volume
m	ft	ha	a	m^3	a-ft	ha	a	m^3	a-ft		
0.0	Tree line										
0.15	0.5	340	841	258,930	210	3,423	8,458	2,607,795	2,115	12.5	1.5
0.30	1.0	298	736	680,616	552	2,357	5,825	5,386,977	4,369	8.6	3.2
0.46	1.5	310	767	1,182,447	959	2,892	7,146	11,014,389	8,933	10.6	6.5
0.61	2.0	453	1,119	2,414,214	1,958	4,503	11,127	24,008,976	19,472	16.4	14.1
0.76	2.5	662	1,637	4,541,139	3,683	4,606	11,381	31,573,431	25,607	16.8	18.6
0.91	3.0	680	1,680	5,695,227	4,619	3,922	9,692	32,863,149	26,653	14.3	19.3
1.07	3.5	265	654	2,621,358	2,126	2,637	6,516	26,113,707	21,179	9.6	15.4
1.22	4.0	153	378	1,745,928	1,416	1,456	3,597	16,629,471	13,487	5.3	9.8
1.37	4.5	14	35	182,484	148	606	1,497	7,845,579	6,363	2.2	4.6
1.52	5.0	11	28	161,523	131	246	607	3,554,739	2,883	0.9	2.1
1.68	5.5	3	8	51,786	42	294	727	4,906,107	3,979	1.1	2.9
1.83	6.0	...	...	...	...	...	...	...	...	...	...
2.13	6.5	...	...	...	...	71	175	1,401,921	1,137	0.3	0.8
2.44	7.0	...		...		...	...	...	...	...	...
2.74	7.5	...	...			42	103	949,410	770	0.2	0.6
2.74 + channel	8.0					...	...	...	...	...	...
	8.5		...			45	111	1,163,952	944	0.2	0.7
	9.0					...	...	...		...	...
	9.0 + channel					305	754	...		1.1	...
Total		*3,189*	*7,883*	*19,535,652*	*15,844*	*27,405*	*67,716*	*170,019,603*	*137,891*	*100.1*	*100.1*
Average depth[a]		0.61 m, 2.0 feet				0.62 m, 2.0 feet					

[a]Volume ÷ depth, excluding channel

U.S. Army Corps of Engineers, had a moderate effect on water areas in the valley. From the confluence of the Des Plaines and Kankakee rivers, which form the Illinois, six dams separate the river into long, narrow navigation pools: Dresden Island, Marseilles, Starved Rock, Peoria, La Grange, and Alton. The locks and dams at Starved Rock and above were completed in 1933, those at Peoria and La Grange in 1939, and that at Alton in 1938. Each navigation pool is maintained at a minimum depth of 2.7 m (9 feet), but depths increase during periods of flooding.

The navigation pools in the Illinois River proper are termed "flat pools" by engineers because of the slight water-surface slope from the upper end to the dam under low-flow conditions. With high-flow levels, the upper end of a pool may be as much as 1.5 m (5 feet) higher than the lower end. The dams enable an increasing water flow to be spilled until the upper end of one pool becomes as high as the lower end of the one immediately above. At normal river stages, water velocity is less than 1.6 km (1 mile) per hour. The low rate of flow compounds the problem of sedimentation.

The change wrought by the dams on the surface area of water in the Illinois Valley was nominal (Table 5). One reason that the increase was not more drastic was the curtailment in diverted water that occurred at that time. The most noticeable change occurred immediately above the Dresden Island and Starved Rock locks and dams, where the main channel was greatly broadened to the benefit of fish and waterfowl (Havera et al. 1980).

Increases in the open water of bottomland lakes because of the impounding of Peoria and La Grange pools occurred largely at the expense of marshes that succumbed to deeper water (Table 5). Overall there was a decrease of wetlands in these two pools, because sedimentation allowed the invasion of black willows into more aquatic habitats (Bellrose et al. 1977).

Impoundment by the Alton Navigation Dam on the Mississippi River appreciably enlarged bottomland water areas on the lower Illinois River (Table 5). Most of this increase occurred in the lower 32 km (20 miles) of the river valley between Hardin and Grafton.

FIELD DETERMINATIONS

Surface Area

The surface areas of the few bottomland lakes existing in the upper navigation pools were measured by planimeter from the 1974 aerial photos (Table 6). The surface area and water volume within each 0.15-m (0.5-foot) contour interval and the average depths of selected lakes are presented by pools in Tables 7 through 11.

About 28,601 ha (70,672 acres) of bottomland lakes occurred in the Illinois River valley, 1976–1979 (Tables 6 and 11). Of the designated pools in the Illinois River valley, the upper navigation pools (Dresden Island, Marseilles, and Starved Rock) had the smallest number of bottomland lakes (11) and smallest water surface area (1,196 ha or 2,956 acres) (Table 6). The few bottomland areas in the upper pools are a result of the narrow river valley in this portion of the waterway and a greater rate of fall in the river above than below Starved Rock. Peoria Pool had the largest area in bottomland lakes (13,295 ha or 32,858 acres) mainly because of Peoria Lake, a large lake in the main stem (Table 11). The water surface area of bottomland lakes in La Grange Pool totaled 10,919 ha (26,980 acres) (Table 11). Alton Pool had 3,189 ha (7,883 acres) of surface water in its bottomland lakes (Table 11). Peoria and La Grange pools combined contained 85 percent of the total surface area and 102 of the 146 (70 percent) bottomland lakes in the Illinois Valley.

Volume of Water

In Peoria Pool, about 74 percent of the estimated 40 million m³ (32,000 acre-feet) of water volume in the bottomland lakes (excluding Peoria Lake) occurred between 0.46 and 0.91 m (1.5 and 3.0 feet) below the tree line water level (Table 11). Peoria Lake, however, contained 75 percent of its 51.7 m³ (42,000 acre-feet) of estimated water volume between 0.76 and 1.37 m (2.5 and 4.5 feet) below pool level. Peoria Lake contained almost three-quarters as much surface area as all the other lakes in Peoria Pool and exceeded their combined volume by approximately 11.6 million m³ (9,500 acre-feet), denoting its greater depth. La Grange Pool had about the same surface acreage and volume in bottomland lakes as Peoria and Alton pools combined, with the exclusion of Peoria Lake (Table 11). In La Grange Pool, 76 percent of its calculated 58.7 million m³ (47,600 acre-feet) of water volume occurred between 0.61 and 1.07 m (2.0 and 3.5 feet), about 0.3 m (1 foot) deeper than the comparable bottomland water areas in Peoria Pool (Table 11). Alton Pool had the smallest surface area and water volume in bottomland lakes compared with those of Peoria and La Grange pools. It is similar in depth to La Grange Pool, with 78 percent of its estimated 19.5 million m³ (15,840 acre-feet) of volume occurring between 0.61 and 1.07 m (2.0 and 3.5 feet) below the tree line. For the Illinois River valley from Utica to Grafton, we calculated an estimated total volume of 170 million m³ (137,900 acre-feet) when the water is at the tree line, with about 77 percent of the volume occurring between 0.61 and 1.22 m (2.0 and 4.0 feet) below the tree line (Table 11).

Depth

Perhaps the most striking and discouraging finding from our investigations is that in 1976–1979 the average depth of bottomland lakes in the Illinois Valley was only 0.62 m (2.0 feet) (Table 11). Because of the filling in of lakes as a result of the severe sedimentation in the valley, the lakes in Peoria Pool (except Peoria Lake) averaged only 0.52 m (1.7 feet) in depth (Table 11). Peoria Lake averaged 0.97 m (3.2 feet), the lakes in La Grange Pool averaged 0.55 m (1.8 feet), and Alton Pool lakes averaged 0.61 m (2.0 feet) (Table 11).

Although most of the bottomland lakes closely resemble one another, there are some differences. The shallowest lake that we sampled (Goose Lake, Peoria Pool; 0.32 m, 1.1 feet; Table 7) has a tributary stream that flows into it, further aggravating the serious sedimentation problem arising from the main stem of the river. Historically, Peoria Lake has been deeper than all other bottomland lakes, and the channel flows through it. We believe that before the building of the Peoria Lock and Dam in 1939, the channel current transported more of the sediment load through the lake than it has since that time. Apparently because of the reduced current resulting from the dam, a greater proportion of the channel sediment load is now being deposited in Peoria Lake. In La Grange Pool, two of the deepest lakes are Rice and Anderson with an average depth of about 0.74 m (2.4 feet) (Table 9). Rice Lake has remained relatively deep

as a result of its distance from the river and of low levees that have reduced the ingress of river water. Low levees have also protected Anderson Lake from inundation by small and moderate floods.

Mud Flats

The areas of mud flats of selected lakes in Peoria and La Grange pools at 0.15-m (0.5-foot) contour intervals and the mud-flat area extrapolated for all lake basins in these pools are presented in Tables 12 and 13. We also calculated the percentage of time for each year between 1939 and 1978 that water levels occurred at each mean sea level stage in the period 10 July–1 October. Exposed mud flats during this period are necessary for the establishment of moist-soil plants (Fig. 6), currently the primary source of naturally occurring foods for waterfowl. If mud flats are exposed and moist-soil plants become established for at least 70 days and are not overtopped by water during this critical period, plants mature and produce seed, which is then available to waterfowl. However, moist-soil plants are generally killed by complete inundation before maturation. For optimum development of moist-soil food resources, 90 days are desirable. Fewer than 70 days results either in seeds not maturing or in a low volume of seed production.

The area of mud flats exposed varies from year to year as summer water levels change. In Peoria Pool, about 2,406 ha (5,945 acres) of mud flats are potentially available (Table 12). This maximum area of mud flats occurred with low-water conditions that prevailed about 47.5 percent of the time during the 1939–1978 period (Table 12). In

Table 12.—The number of hectares (acres) of mud flats potentially available in selected lakes of Peoria Pool in relation to mean sea level river stages at Henry for the entire moist-soil-plant growing season, 10 July–1 October, 1939–1978.

Lake	MSL at Henry in Feet				
	442.1+	441.5	441.0	440.5	Total
Depue Lake	Above tree line	Tree line	38 (94)	35 (86)	73 (180)
Goose Lake			180 (444)	186 (459)	366 (903)
Senachwine Lake			171 (423)	85 (210)	256 (633)
Sawmill Lake			70 (172)	23 (57)	93 (229)
Billsbach Lake			66 (164)	47 (116)	113 (280)
Sparland Lake			106 (262)	45 (111)	151 (373)
Babbs Slough			236 (583)	97 (240)	333 (823)
Total area			*867 (2,142)*	*518 (1,279)*	*1,385 (3,421)*
Extrapolated area for Peoria Pool[a]			1,465 (3,620)	941 (2,325)	2,406 (5,945)
Percent of yearly occurrence[b]	12.5	15.0	25.0	47.5	

[a]Selected lake conditions extrapolated for the entire pool area on the basis of seasonal stages by years (Table 11).

[b]Percentage of years from 1939 to 1978 that water levels for the period 10 July–1 October averaged this height.

Table 13.—The number of hectares (acres) of mud flats potentially available in selected lakes of La Grange Pool in relation to mean sea level river stages at Havana for the entire moist-soil-plant growing season, 10 July–1 October, 1939–1978.

msl Havana (feet)	Rice Lake	Beebe Lake	Goose Lake	Clear Lake	Lake Chautauqua	Anderson Lake	Grand Island	Ingram-Stewart Lakes	Chain Lake	Crane Lake	Total Area	Extrapolated Area La Grange Pool[a]	Percent of Yearly Occurrence[b]
434.9+	Above tree line												5.0
434.4	Tree line												2.5
433.9	85 (209)	98 (243)	47 (116)	103 (254)	203 (502)	78 (193)	139 (343)	144 (355)	24 (60)	34 (84)	955 (2,360)	1,618 (3,998)	0.0
433.4	21 (52)	68 (168)	18 (44)	53 (130)	200 (493)	43 (107)	59 (147)	138 (341)	20 (49)	41 (102)	661 (1,632)	1,119 (2,765)	7.5
432.9	28 (69)	119 (294)	28 (68)	62 (154)	212 (525)	40 (99)	50 (123)	168 (416)	16 (39)	59 (146)	782 (1,932)	1,324 (3,273)	10.0
432.4	36 (88)	149 (367)	55 (136)	98 (243)	504 (1,246)	57 (141)	210 (520)	141 (348)	61 (150)	87 (215)	1,398 (3,454)	2,368 (5,852)	7.5
431.9	50 (124)	111 (274)	49 (120)	100 (248)	339 (837)	86 (213)	166 (409)	205 (506)	62 (154)	88 (94)	1,205 (2,978)	2,042 (5,045)	15.0
431.4	143 (353)	7 (17)	...	169 (417)	64 (159)	100 (247)	24 (59)	78 (193)	43 (107)	28 (69)	655 (1,619)	1,110 (2,744)	15.0
430.9	193 (478)	1 (3)	...	141 (349)	...	123 (303)	38 (93)	...	...	26 (63)	522 (1,290)	884 (2,185)	17.5
430.4	56 (138)	...	...	55 (137)	...	136 (335)	9 (21)	...	...	8 (19)	264 (652)	447 (1,104)	20.0
Total	*612 (1,511)*	*553 (1,366)*	*197 (484)*	*781 (1,932)*	*1,522 (3,762)*	*663 (1,638)*	*695 (1,715)*	*874 (2,159)*	*226 (559)*	*321 (792)*	*6,442 (15,917)*	*10,912 (26,966)*	*100.0*

[a]Selected lake conditions extrapolated for the entire pool area on the basis of seasonal stage by years (Table 11).

[b]Percentage of years between 1939 and 1978 that water levels for the period 10 July–1 October averaged this height.

Fig. 6.—Lake Chautauqua from the southeast shore in August 1979. Extensive mud flats have been exposed by receding water levels in the shallow, platter-shaped basin.

comparison, La Grange Pool has potentially 10,912 ha (26,966 acres) of mud flats, about four and a half times as much as Peoria Pool (Table 13). However, the maximum area of mud flats occurred in La Grange Pool only about 20 percent of the time during the growing seasons of 1939 through 1978. Water levels vary less in Peoria Pool than they do in La Grange Pool, because the Peoria dam is 0.3 m (1 foot) higher than the La Grange dam, the slope of the river is less acute in Peoria Pool, and large tributary streams add more sizeable discharges to the river in La Grange Pool.

SEDIMENTATION

Lee & Stall (1976:27) made a theoretical calculation of the annual sediment loss in the Illinois River Basin of 25 million metric tons (t) (27.6 million tons) or 3.34 t/ha (1.49 tons/acre). They calculated that 62 percent of the silt came from valley slopes of tributary rivers and the parent valley, and 38 percent from upland areas. About 11 million t (12.1 million tons) of sediment are annually transported out of the Illinois Valley to the Mississippi River at Grafton, leaving 14 million t (15.4 million tons) deposited in the water areas and certain unleveed areas of the floodplain. Lee & Bhowmik (1979:18, Fig. 6) show the rate of sediment transport in relation to the volume of water in the Illinois River. They found little transport of sediment with low discharge and increases in sediment load with increasing water volume until a saturation threshold is reached.

An analysis by Lee & Stall (1977:51–52) of the deposited sediments revealed that they were made up almost equally of silt and clay particles and insignificant amounts of sand. Lee & Stall suggested that sediments originated on upland watersheds and were transported to the Illinois River by tributary streams. A dry volume weight of 1,179 t (1,300 tons) of sediment would cover 0.4 ha (1 acre) to a depth of 30.5 cm (1 foot). The dry volume weight was determined by weighing the wet samples, oven drying the samples, reweighing them, and applying the data to a standard equation (Lee & Stall 1977:49). Thus, 14 million t (15.4 million tons) of sediment deposited annually in the Illinois Valley would cover 57,529 ha (142,154 acres) to a depth of 2.5 cm (1 inch).

About 58,276 ha (144,000 acres) of unleveed bottomland between La Salle and Grafton are subject to flooding (Mulvihill & Cornish 1929:37). To this would be added the 27,400 ha (67,693 acres) of lake surface (Table 1) and approximately 8,903 ha (22,000 acres) of river surface, aggregating 94,579 ha (233,700 acres).

Thus, under a maximum overflow of the river's natural banks, 94,579 ha (233,700 acres) would be subject to the deposit of 14.6 million m^3 (11,845 acre-feet) of sediment (Lee & Stall 1976:27), yielding an average of 0.63 cm/ha (0.61 inch/acre). Seldom does a flood cover this extensive

TABLE 14.—The total sediment and yearly amount of sediment in certain bottomland lakes of the Illinois River valley.

Navigation Pool	Lake	Time Interval	Average Annual Sediment Deposit in Centimeters	Average Total Sediment in Centimeters
Peoria	Senachwine	1903–1978	1.27	94.9
	Sawmill	1903–1978	1.11	83.4
	Billsbach	1903–1978	1.12	83.8
	Sparland	1903–1978	1.07	79.9
	Babbs Slough	1903–1978	0.71	52.9
	Upper Peoria	1903–1965[a]	1.67[b]	103.8
		1965–1976[a]	3.06	33.7
		1903–1976	1.88	137.5
La Grange	Clear	1903–1978	1.56	117.3
	Beebe	1903–1978	0.75	56.4
	Rice	1903–1977	0.26	19.1
	Chautauqua	1926–1950	1.05[b]	25.1
		1950–1976	1.06	27.4
		1926–1976	1.05	52.5
	Matanzas	1903–1979	1.62	122.8
	Anderson	1903–1977	0.41	30.5
	Grand Island[c]	1903–1978	0.95	71.0
Alton	Meredosia	1903–1956[d]	1.30[b]	68.9
		1956–1978[d]	1.19	26.2
		1903–1978	1.27	95.1
	Swan	1903–1978	0.85	64.1
Overall average			*1.06*	
Weighted average based on area of lake basins			1.24	

[a]U.S. Army Corps of Engineers 1965, 1976

[b]Where three time periods are shown, only the longest period was used to calculate the overall average and the weighted average

[c]Grass, Goose, and Jack lakes

[d]Illinois Division of Waterways 1956

an area. However, as the river rises, an increasing load of sediments enters the lateral lakes. There are 26,300 ha (89,700 acres) of water surface in the river and bottomland lakes. If they received the entire sediment load that Lee & Stall (1976:27) calculated is deposited annually in the Illinois Valley, it would fill the beds of these areas at the rate of 1.63 cm/ha per year (1.58 inches/acre per year). Because part of the sediment is deposited on adjacent floodplain lands, the calculated deposition of sediments in the waters of the Illinois Valley would be between 0.63 cm/ha and 1.63 cm/ha per year. Using the sedimentation rates for a cross section of lakes, 1903–1979 (Table 14), we calculated a weighted mean of 1.24 cm/ha per year. Because sedimentation rates have been higher in the recent years of that period, the 1.24 cm of sediments deposited yearly appears conservative and approximates the estimates by Lee & Stall (1976:27) derived from an entirely different basis employing the universal soil loss equation (Upper Mississippi River Comprehensive Basin Study Coordinating Committee 1970).

The sedimentation of bottomland lakes in the Illinois Valley has been studied by the Illinois State Water Survey (Lee & Stall 1976, 1977; Lee & Bhowmik 1979) and the Illinois Natural History Survey (Bellrose et al. 1979). The studies by the Water Survey have centered on the diminution of the storage capacity of bottomland lakes as a result of sedimentation. Those by the Illinois Natural History Survey have been concerned with yearly sedimentation rates in relation to water depth.

It is important to make a distinction between the terms "sedimentation rate" and "amount of sedimentation." Sedimentation rate is the thickness of sediments that have been deposited at a given water depth during 1 year. The amount of sedimentation or fill refers to the quantity of sediments deposited over an entire lake basin or at a specific location during an elapsed time of 1 or more years. The sedimentation rate provides a means of comparing the amount of sedimentation at similar water depths between years and between lakes.

These terms are important because Bellrose et al. (1979:30–32) found that as the water depth increased, the sedimentation rate increased. Sedimentation in a body of water, therefore, becomes a dynamic factor—subject to change as water depths change. It has resulted in the basins of the bottomland lakes changing from a diversity of depths to uniformly shallow, platter-shaped collections of ooze.

Linear regression trend lines are used to compare sedimentation rates with water depths for a number of lakes in each of the lower three navigation pools (Fig. 7, 8). The y-intercept for the trend lines is negative for 6 of the 10 lakes. Apparently, at the interface between water and land, ice and wave action have eroded bottom soils, thus actually deepening the lake basins slightly in shoal areas. In some cases, entire islets and low peninsulas have been washed away, most evident at Senachwine and Chautauqua lakes. However, elsewhere the basins have become very shallow from the deposition of sediments. Some of the sediments deposited in deeper water were originally displaced by ice and waves, but this movement of material within a lake is minuscule compared with the volume of sediments brought in by the river.

In our endeavor to determine the basin capacities of the

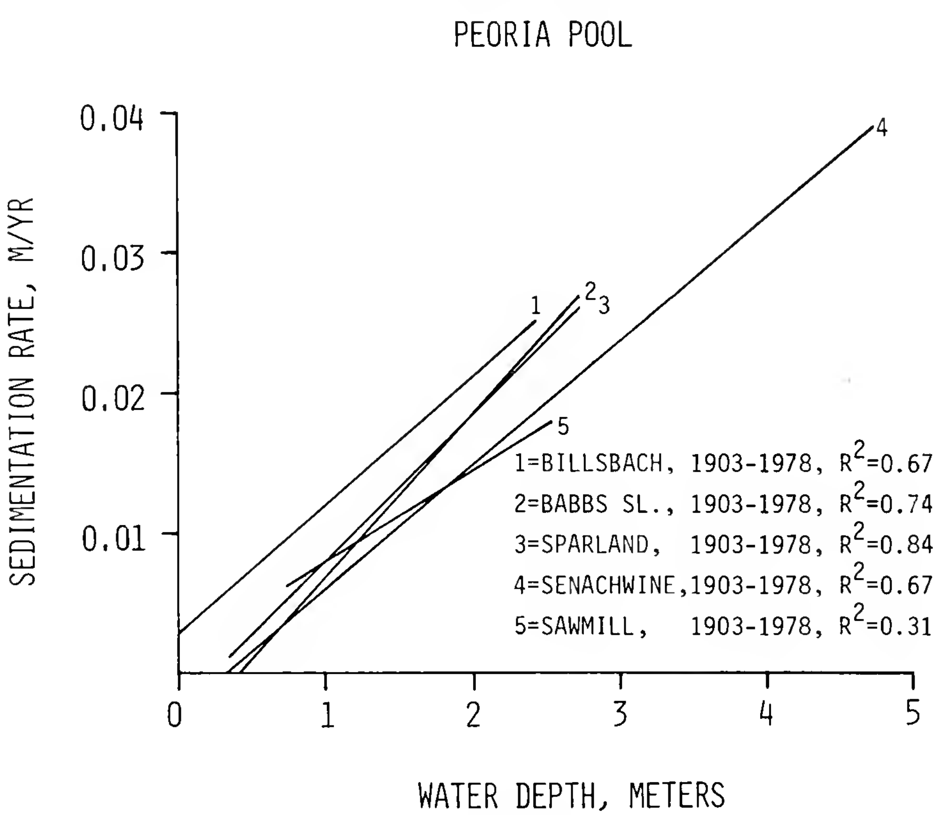

Fig. 7.—Linear relationships between the depth of water and the yearly rate of sedimentation in five bottomland lakes in Peoria Pool. All relationships are significant ($P < 0.01$).

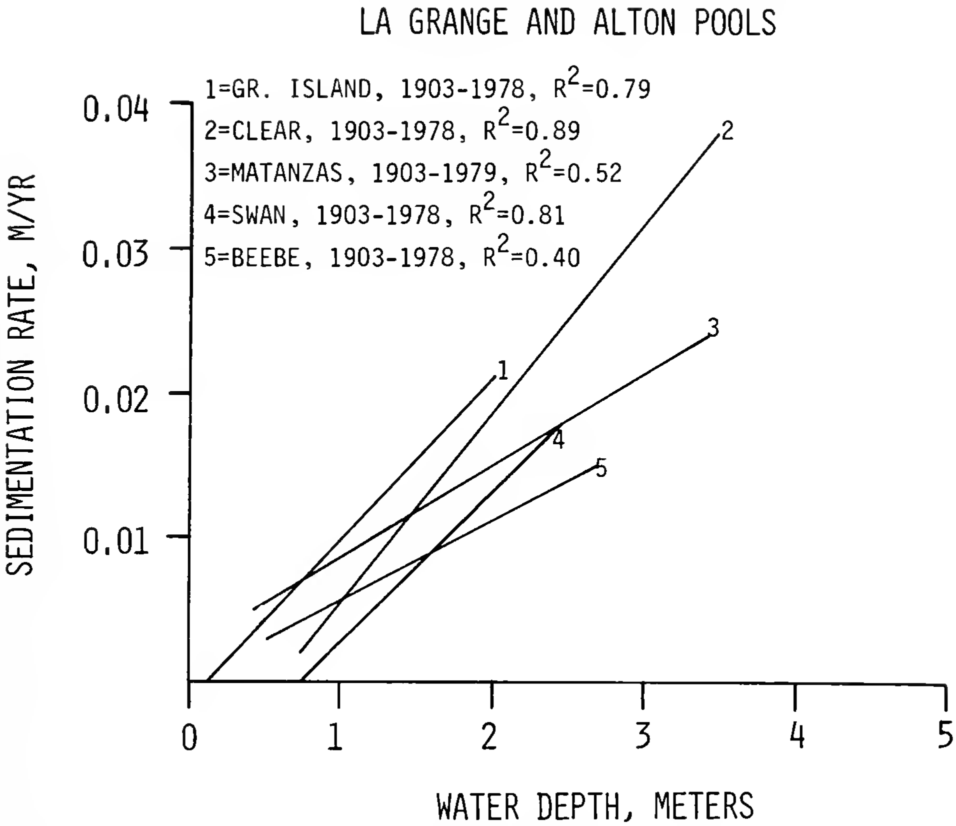

Fig. 8.—Linear relationships between the depth of water and the yearly rate of sedimentation in five bottomland lakes in La Grange and Alton pools. All relationships are significant ($P < 0.01$).

bottomland lakes in the Illinois Valley, some of the lakes surveyed in 1976 for deposited sediments (Bellrose et al. 1979:30) were resurveyed in 1978. More transects were made in each lake in the 1978 surveys, and all transects extended from wooded shoreline to wooded shoreline. Because of low-water conditions on certain lakes, transects in the 1976 survey did not always extend as far as the shoreline. At that time, we did not recognize that this failure would create a slightly erroneous extrapolation of the relationship between water depth and sedimentation rate, because shoreline areas have the lowest sedimentation rates (because of reduced water depths) and may in some instances actually be deepened by ice and waves.

Therefore, we have included in this paper linear regression trend lines comparing sedimentation rates with water depths for lakes that were surveyed in 1978–1979 (Fig. 7, 8), including some of those surveyed in 1976 and previously reported (Bellrose et al. 1979:30, Fig. 9). The principal difference between the results obtained by the 1976 survey and the 1978 survey occurred in the lakes of Peoria Pool, the 1978 survey resulting in slightly lower regression slopes and in greater negative y-intercepts for a number of lakes (Fig. 7; Bellrose et al. 1979:30, Fig. 9).

Sedimentation rates are high for Babbs Slough (Fig. 7) and for Grand Island lakes and Clear Lake (Fig. 8); they are low for Beebe, Matanzas, and Sawmill lakes (Fig. 7, 8).

The rates of sedimentation shown for lakes of the Illinois Valley are alarming, particularly because of the existing shallow waters. Moreover, if more recent time periods than 1903–1978 are considered, the sedimentation rates are appreciably higher and, therefore, more critical (Fig. 9; Bellrose et al. 1979:32, Fig. 11, 12, 13).

A number of lake basins were partially or entirely surveyed for bottom elevations between 1903 and our 1978 survey. In 1936 the Peoria Office, U.S. Army Corps of Engineers, surveyed the river-side half of five lakes: Senachwine, Sawmill, Billsbach, Sparland, and Babbs Slough. We used our bottom elevations from 1978 for the same transect sections to make comparisons on the change of sedimentation rates between 1903–1936 and 1936–1978 (Fig. 9). It is apparent that during the later period, 1936–1978, the sedimentation rates for all five lakes combined were higher, particularly in the shallower waters, than they were in the earlier period, 1903–1936 (Fig. 9).

A recalculation of the amount of sedimentation for several lakes surveyed in 1976 and reported in Bellrose et al. (1979:34) and data for some additional lakes are presented in Table 14. A comparison of current data with the yearly amount of sedimentation given by Bellrose et al. (1979:34) provides these differences between 1976 and 1978 surveys: Senachwine, Sawmill, Billsbach, and Sparland had slightly lower amounts of sediment deposits, whereas Babbs Slough, Upper Peoria Lake, and Chautauqua had slightly higher amounts. We found higher amounts of sedimentation in more recent years for Lake Chautauqua, Meredosia Lake, and especially Upper Peoria Lake. For example, data from the 1965–1976 period show that Upper Peoria Lake now averages about 1 m (3.2 feet) in depth and is being filled in over its entire basin at an average amount of 3.1 cm/year (1.2 inches/year) (Table 14).

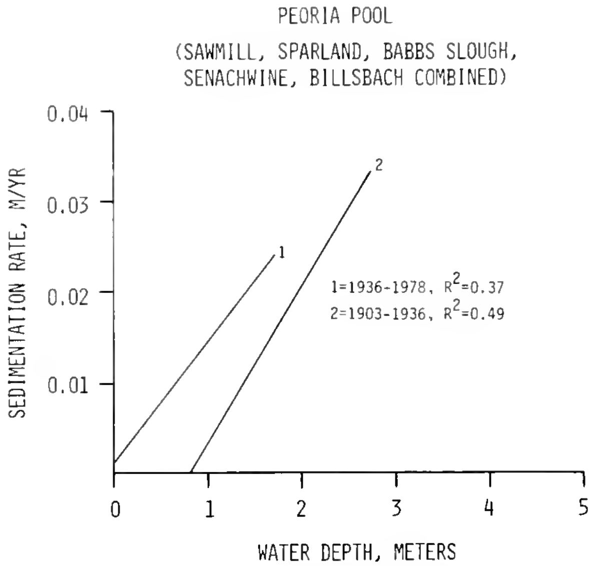

Fig. 9.—Linear relationships between the depth of water and the yearly rate of sedimentation for half of Senachwine and of Sawmill, Billsbach, and Sparland lakes and Babbs Slough combined for two time periods. The relationships are significant ($P < 0.01$).

OUTLOOK FOR THE FUTURE

Because of our concern with the extreme sedimentation problem occurring in the Illinois River valley, we have projected our current knowledge of sedimentation rates and average depths of the bottomland lakes into the 21st century. Ideally, we wish to achieve some plausible index to the longevity, both biological and recreational, of the bottomland water areas. We have attempted to estimate how much longer the Illinois River bottomland lakes will afford recreational opportunities for limited fishing, duck hunting, and boating.

Information from the linear regressions of sedimentation rates versus depths for individual lakes (Fig. 7, 8; Bellrose et al. 1979:30–32) and the 1976–1979 depths of each lake (Tables 7–10) were used in a modified half-life equation typically employed for chemical reactions. Because sedimentation is dynamic, with the rate under constant modification as waters become shallower, we believed that a mathematical relationship using the slope of the linear regression of sedimentation rates versus depths would be appropriate. We also realized that it may be more accurate to estimate when the bottomland lakes would be filled to half their current depth rather than when they would be completely filled, because sedimentation rates are reduced and subject to other influences in extremely shallow water. In addition, when the lakes are filled to half of their current depth, they will have little biological or recreational value.

Dr. Saul Blumenthal, Department of Mathematics, University of Illinois, used the following rationale to develop an equation for estimating the number of years required for a given bottomland lake to fill to half of its average 1976–1979 depth. The linear regressions of sedimentation rate versus depth (Fig. 7, 8) can be expressed as

$$\frac{dS(t)}{dt} = kY(t) + b \tag{1}$$

Where

$\frac{dS(t)}{dt}$ = sedimentation rate

$S(t)$ = thickness of sediment accumulated at time t

$Y(t)$ = depth of water at time t

k = slope of sedimentation regression line

b = y-intercept of sedimentation regression line

However, the depth of water $Y(t)$ is decreasing as the sediment depth increases. Therefore,

$$\frac{dY(t)}{dt} = \frac{-dS(t)}{dt}$$

and equation (1) becomes

$$\frac{dY(t)}{dt} = -kY(t) - b \tag{2}$$

The general solution to differential equation (2) is

$$Y(t) = Ae^{-kt} - \frac{b}{k} \tag{3}$$

Where

A = an arbitrary constant

If we set the current time to zero ($t = 0$) in equation (3), we can relate A to the water depth (Y_0) at the present time. Equation (3) then becomes

$$Y_0 = A - \frac{b}{k} \quad \text{or} \quad A = Y_0 + \frac{b}{k}$$

Equation (3) can then be rewritten as

$$Y(t) = (Y_0 + \frac{b}{k})e^{-kt} - \frac{b}{k} \tag{4}$$

We can now solve equation (4) for the time t required for a given bottomland lake to fill to half its average 1976–1979 depth (Y_1):

$$t = \frac{1}{k} \ \ln \cdot \frac{Y_0 + \frac{b}{k}}{Y_1 + \frac{b}{k}} \tag{5}$$

Where

t = number of years

k = slope of sedimentation regression line

b = y-intercept of sedimentation regression line

Y_0 = 1976–1979 average depth

Y_1 = half of 1976–1979 average depth

The results of equation (5) in predicting the number of years in which selected lakes will lose half of their average

TABLE 15.—Projected number of years required for selected bottomland lakes to be filled to half of their average 1976–1979 depth. Predictions were generated from a "half-life" equation using values from linear regressions (both actual and forced through the origin) of sedimentation rates vs. depth

Lake	Dates for Sedimentation Rate	1976–1979 Depth in Meters	Actual Regression Equation		Regression Forced Through Origin	
			R^2	Years	R^2	Years
		Peoria Pool				
Senachwine	1903–1978	0.66	...		0.65[a]	91
Sawmill	1903–1978	0.54	0.31[a]	74	0.31[a]	97
Sparland	1903–1978	0.41	0.84[a]	...	0.81[a]	81
Babbs Slough	1903–1978	0.45	0.74[a]	...	0.64[a]	87
Billsbach	1903–1978	0.55	0.67[a]	44	0.63[a]	63
Upper Peoria	1903–1965	0.98	0.63[a]	232	0.62[a]	90
	1965–1976	0.98	0.74[a]	63	0.67[a]	24
	1903–1976	0.98	0.83[a]	182	0.81[a]	82
		La Grange Pool				
Beebe	1903–1978	0.42	0.40[a]	128	0.40[a]	127
Rice	1903–1977	0.74	0.50[a]		0.33[a]	230
Clear	1903–1978	0.65	0.89[a]		0.82[a]	72
Chautauqua	1926–1950	0.46	0.41[a]		0.35[a]	76
	1950–1976	0.46	0.51[a]		0.41[a]	60
	1926–1976	0.46	0.70[a]		0.59[a]	76
Matanzas	1903–1979	0.95	0.52[a]	71	0.51[a]	95
Anderson	1903–1977	0.73	0.57[a]	...	0.42[a]	154
Grand Island lakes[b]	1903–1978	0.48	0.79[a]	110	0.69[a]	72
		Alton Pool				
Meredosia	1903–1956	0.62	0.89[a]		0.69[a]	115
	1956–1978	0.62	0.27[a]	...	0.17[a]	93
	1903–1978	0.62	0.84[a]	...	0.66[a]	119
Swan	1903–1978	0.61	0.81[a]	...	0.63[a]	119

[a] $P < 0.01$

[b] Grass, Goose, and Jack lakes

1976–1979 depth are presented in Table 15. The number of years range between 44 for Billsbach and 74 for Sawmill in Peoria Pool (excluding Peoria Lake) and between 71 for Matanzas and 128 for Beebe in La Grange Pool.

It was not possible to generate a "half-life" value on the basis of the existing linear regressions for several of the selected lakes (Table 15). This difficulty occurred when the y-intercept of the sedimentation regression had a moderate or large negative value. When this value is substituted into the "half-life" equation (5), a natural log of a negative number must be taken, thus prohibiting further calculation.

To remedy these negative y-intercepts and allow use of the "half-life" prediction equation (5), the regressions between sedimentation rates versus depth were rerun for the selected lakes, but the regression line was forced through the origin. We believe that it is hydrologically valid to use this statistical approach. Theoretically, there should be a minimum of sedimentation at the lake margin, and the regression line should go through the origin. However, as previously explained, the effects of wave action on the shoreline, where minimum depths occur, cause erosion of the shore and shallow areas with the resultant translocation of this soil elsewhere in the lake. Thus, in most cases, minimum or negative sedimentation occurred in shallow depths adjacent to the shoreline (Fig. 7, 8, 9).

Once again, the selected lakes in Peoria Pool had shorter "half-lives" than those in La Grange Pool (Table 15). The number of years predicted for the chosen lakes in Peoria Pool to fill to half of their average 1976–1979 depth ranged from a catastrophic 24 years in Upper Peoria Lake to 97 years for Sawmill. The time estimated to fill in half of the average depth for those lakes studied in La Grange Pool varied from 60 years for Lake Chautauqua to 230 years for Rice Lake.

It should be noted that the predictions for Upper Peoria Lake, Chautauqua, and Meredosia, when based on sedimentation rates from recent years (1965–1976, 1950–1976, and 1956–1978, respectively), are shorter than when sedimentation rates covering a longer span of years (1903–1976, 1926–1976, and 1903–1978, respectively) are used (Table 15). As discussed previously, the sedimentation rates are much higher in recent years, thus contributing to the shorter predicted "half-lives." If current land-use practices and accompanying excessive soil losses continue, then our "half-life" calculations are overly conservative.

DISCUSSION

For a brief period in the history of the Illinois River valley, man improved it for fish and waterfowl. This improvement occurred in the early 1900's, as water diverted from Lake Michigan doubled the surface area of the bottomland lakes. Although bottomland forests and their attendant wildlife suffered diminution as thousands of hectares of trees succumbed to inundation, the enhancement for fish and waterfowl was economically much greater.

The commercial catch of fish in the Illinois River rose steadily from 1894 and reached a peak in 1908 (U.S.

Department of Commerce and Labor 1911). At that time the Illinois River provided 10 percent of all freshwater fish caught in the United States. Thereafter, the commercial fish yield of the Illinois River steadily declined (Mills et al. 1966:15).

Following the brief improvement in the first decade of this century, man's activities have been largely destructive to fish and waterfowl as well as other wildlife resources of the Illinois Valley. First, the levees constructed along the river, mostly between 1909 and 1922 (Mulvihill & Cornish 1929:38), resulted in the loss of 17,584 ha (43,450 acres) of water surface, 39 percent of the total (Tables 2, 3). This loss is calculated on the basis of diverted waters doubling the 8,792 ha of lakes present in 1903 before the development of drainage and levee districts. Such a reduction in water area resulted in a comparable decrease in the fish production and waterfowl food resources of the valley.

Urban pollution began to be a problem in the upper river by 1911 (Mills et al. 1966:8–9) and ballooned in scope during World War I. Between 1915 and 1920, the zone of pollution moved downstream from the Chicago area at the rate of 26 km (16 miles) per year (Mills et al. 1966:9); by 1923 the river was almost devoid of free oxygen as far south as Chillicothe (Greenfield 1925:24–25). Pollution abatement in the last two decades has improved the dissolved oxygen levels of the river but not necessarily those of the adjacent bottomland lakes (Sparks & Starrett 1975:345–346). The reduction in oxygen content in the bottomland lakes is attributed to the resuspension of fine silts from the shallow lake bottoms by wave action. The resuspended material exerts an oxygen demand, removing dissolved oxygen from the water (Butts 1974:12).

Fish life has not increased to the degree anticipated from the improvement of dissolved oxygen in the river (Mills et al. 1966; Sparks & Starrett 1975:345). A principal factor appears to be the sediments deposited in the bottomland lakes (Bellrose et al. 1977:IV-a). These lakes play an important role in the fishery of the Illinois Valley. Their potential fish yield in relation to the river is exemplified by Richardson's (1921:464) findings that in 1908 "the largest poundages of fish per acre have been taken in the reaches with the largest quotas of connecting lake-acreage." Richardson (1921:464) pointed out that the fish yield in the lakes was probably greater because of the greater abundance of weed fauna and bottom fauna.

Water turbidity, resulting from sedimentation, has increased in the river and bottomland lakes (Bellrose et al. 1977:C-42). Turbidity reduces the food supply of panfish and game fish and their reproduction (Sparks & Starrett 1975:339). Most aquatic plant beds have been eliminated, and marsh plants have been drastically reduced in the bottomland lakes as a result of turbidity (Bellrose et al. 1979:28–29). Aquatic plants not only benefit fish, but are an important food resource to several species of dabbling and diving ducks.

In addition to the harmful indirect effects of sediments on the fish and wildlife resources of the Illinois River valley, they produce direct effects on the lake basins. Our surveys on the volume of water in Illinois Valley lakes at a normal water stage (the tree line) show that they are extremely shallow (Tables 7–11). Originally they were deeper, and man made them still deeper by either diverted water from Lake Michigan or the construction of navigation dams. However, since 1903 all evidence indicates that sedimentation is increasingly reducing their depths.

We found that between 1903 and 1976–1979, the large lakes in the Illinois Valley had filled with sediments at annual average amounts varying from 0.26 to 1.88 cm (0.10–0.74 inch), and the average for all lakes was 1.06 cm (0.42 inch) (Table 14). Lee & Stall (1976:55) reported that between 1903 and 1975 Sawmill Lake had filled at a yearly amount of 1.19 cm (0.47 inch), Swan Lake (Calhoun County) at 0.46 cm (0.18 inch), and Meredosia Lake at an amount of 1.09 cm (0.43 inch). Our calculations of yearly amounts of sedimentation were slightly different: Sawmill, 1.11 cm (0.44 inch); Swan, 0.85 cm (0.33 inch); and Meredosia, 1.27 cm (0.50 inch) (Table 14).

Studies at several lakes point to higher sedimentation rates in more recent years (Fig. 9). The importance of presenting annual sedimentation rates for two different time periods is that they provide a means of evaluating differences in the sediment load transported by the Illinois River. Fig. 9 compares yearly sedimentation rates for two time periods: 1903–1936 and 1936–1978. The yearly rate was higher in the 1936–1978 period for the five lakes combined. Higher sedimentation rates were also found for the more recent of two time periods for Upper Peoria Lake, Lake Chautauqua, and Meredosia Lake (Bellrose et al. 1979:32; Steffeck et al. 1980).

All of our evidence points to a dramatic increase in the sediment load of the Illinois River during recent years. This increase is not only reflected in higher sedimentation rates, but also in the total amount of sediment, as evidenced in both Upper Peoria Lake and Lake Chautauqua (Table 14). The current status of Lake Chautauqua, exemplifying the condition of many other floodplain lakes, is portrayed in Fig. 6.

The "half-life" equation (5) provides a means of using the history of sedimentation to predict its effect upon the lakes of the Illinois Valley in the future. Half of the meager volume of these lakes will be lost in a relatively few decades (Table 15). Although much of the sport and commercial fishery value has already been lost as a result of sedimentation, the bottomland lakes are still intensively used by duck hunters. But, in time, these lakes will become so shallow that they cannot be navigated by boat, and the bottoms so soft that they cannot be waded. At that time, they will no longer be useable for duck hunting.

Upper Peoria Lake should be especially singled out for attention. It is the most important recreational lake in central Illinois, especially for Peoria, one of the state's largest cities. Peoria Lake is the largest lake in the Illinois Valley, and since the days of Pere Marquette and Joliet it has undoubtedly been the deepest. Yet, if we employ the sedimentation rates from 1965 to 1976, Upper Peoria Lake may lose approximately half of its volume by the year 2000 (Table 15) when its average depth would be about 0.5 m (1.6 feet). At that depth, water-related activities will become

increasingly restricted. The river channel that passes through the lake will be less affected by sedimentation, because towboats continually resuspend and move the sediments in the channel bed laterally and downstream.

The "half-life" projections based upon sedimentation rates for earlier time periods indicate longer lives than do "half-life" calculations for more recent periods. For example, consider the "half-life" values with the corresponding time periods: Upper Peoria—90 years for 1903–1965 and 24 years for 1965–1976, and Meredosia Lake—115 years for 1903–1956 and 93 years for 1956–1978 (Table 15).

Using the proportion of lake basin filled with sediments during the 1903–1975 period, Lee & Stall (1976) calculated these longevities for two Illinois Valley lakes: Depue 33 years and Meredosia 90 years. Lee (1976) projected the expected life of Lake Chautauqua at 92 years. Their calculations were based on a constant amount of sediment regardless of the lessening depth or changing sedimentation rates during the 1903–1975 period.

Sediments filling in the bottomland lakes of the Illinois Valley are being transported to the main stem of the river largely from the drainage basins of tributary streams. Sediments originate from bank erosion, erosion of bluff areas, and sheet erosion of prairie farm lands. Lee & Stall's (1976:25) calculation of the annual sediment load from the basins of tributary streams carried into the main stem of the Illinois River and deposited in the lakes and floodplain approximates the annual amounts of sediment that we determined for the lakes of the Illinois Valley (Table 14). Thus, the general source of the sediments has been identified. But once in the Illinois River, other factors affect sedimentation.

The deposition of sediments in the Illinois River since 1910 has probably been almost doubled because drainage and levee districts have removed nearly half of the floodplain from inundation by the river. Fig. 10 shows Thompson Lake Drainage and Levee District (which drained Thompson Lake near Havana), the main stem of the river, Lake Chautauqua, and Quiver Lake. The removal of such a large segment of the floodplain increased flood heights,

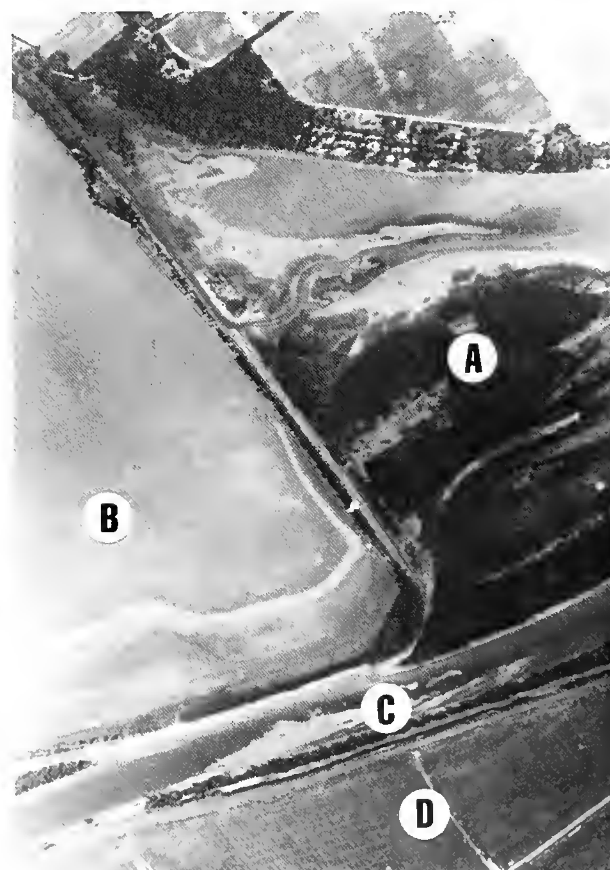

Fig. 10.—Aerial views of the Illinois River valley approximately 8 km north of Havana in 1931 (left) and 1978 (right). Designated areas are Quiver Lake (A); Lake Chautauqua, a national wildlife refuge, (B); Illinois River (C); and Thompson Lake Drainage and Levee District (D). Note the extensive area of Quiver Lake (A) that had been filled by sedimentation by 1978. Thompson Lake Drainage and Levee District (D) converted famous Thompson and Flag lakes to agricultural fields in 1921.

which in turn increased sedimentation rates as a result of the water depth-sedimentation syndrome elucidated earlier (Fig. 7, 8, 9).

The bottomland lakes serve as an important adjunct to the river as a floodway. Because sedimentation is reducing the depths of these lakes, their capacity to conduct flood waters through or to store water in their basins is being further curtailed. Thus, the magnitude of flood heights will rise and the frequency of flooding will increase as the bottomland lakes fill with sediments and eventually become bottomland forests. The filling of Quiver Lake and the resulting growth of willows and cottonwoods (Fig. 10) is illustrative of the future of these lakes and the manner in which their use as a floodway will diminish with the passing of time.

The resuspension of sediments by the passage of towboats in the Illinois River also adds appreciably to the sediments entering certain bottomland lakes. Near the mouth of the Illinois River (mile 3.0) tow traffic in 1977 increased the sediment volume entering backwater areas by an estimated 31.2 percent (Simons et al. 1981:4.28). They postulate that unconstrained river traffic will increase the volume of sediment to 46.8 percent above the natural volume entering backwater areas by the year 2000.

It should be emphasized that these sediments initially entered the river almost entirely from the erosion of upland soils and tributary stream banks. The resuspension of sediments by towboat traffic is a problem of secondary importance. The primary problem is the erosion of Illinois farmlands.

Peoria Lake is filling most rapidly at its upper end, the area nearest to the entrance of the river channel at Chillicothe. This filling is probably related to the reduction of river currents by about one-third by the Peoria Navigation Dam, resulting in greater deposits of sediments above the dam. Moreover, it is the only lake through which the river channel flows, subjecting the lake to a continuous load of sediments. The other bottomland lakes are lateral to the river channel and receive sediments largely during periods of inflow from the rising river or bank overflow.

In the early 1900's, the Illinois Valley had few equals in the nation as a fish and wildlife paradise. It has since been severely impacted by man, and it will lose its bottomland lakes if the sedimentation problem is not resolved in the next two decades. Unless current abusive land practices are abated, there is little hope that the bottomland lakes will be a useable recreational area for more than a few decades. The most feasible alternative is to use selected drainage and levee districts for both flood control and recreation, as proposed by Walraven (1950). An increase in diverted water from Lake Michigan would be advantageous if adapted to seasonal needs. However, the resuspension of soft bottom sediments would reduce the potential value of such a measure.

SUMMARY

1. Early in this century, man briefly enhanced the fish and waterfowl resources of the Illinois Valley by doubling the surface area of its bottomland lakes by diverting Lake Michigan water into the Illinois River.

2. Between 1909 and 1922, drainage and levee districts were constructed which drained almost half of the existing bottomland lakes. By removing about half of the floodplain from inundation by the river, drainage and levee districts have increased flood heights and the deposition of sediments on the remaining lakes and unleveed floodplain of the Illinois Valley.

3. We estimated a total surface area of approximately 27,400 ha (67,700 acres) and a volume of 170,019,600 m^3 (137,900 acre-feet) for the bottomland lakes in the Illinois River valley from Utica to Grafton for the period of 1976 to 1979.

4. Because sedimentation fills in deep water at a faster rate than it fills shallow water, bottomland lakes now are uniform, platter-shaped basins that have a low volume-to-surface-area ratio.

5. At normal water level, bottomland lakes above Upper Peoria Lake in Peoria Navigation Pool average only about 0.52 m (1.7 feet) in depth. Lakes in La Grange Navigation Pool average 0.54 m (1.8 feet), and those in Alton Navigation Pool average 0.61 m (2.0 feet) in depth. Upper Peoria Lake averages 0.98 m (3.2 feet) in depth and, along with Lower Peoria Lake, is the deepest in the Illinois Valley.

6. In the last two decades sedimentation rates have risen to alarming levels as agricultural practices have resulted in increasing soil erosion in the Illinois Valley watershed. It has been calculated that the annual sediment loss in the Illinois River Basin amounts to 25 million metric tons (27.6 million tons). About 14 million metric tons (15.4 million tons) are deposited each year in Illinois Valley lakes and the unleveed floodplain, and 11 million metric tons (12.1 million tons) are transported into the Mississippi River.

7. The deposition of sediments in the bottomland lakes is dynamic, because the annual rate lessens as the lakes become shallower. Therefore, to approximate when selected lakes may lose half of their current average depths, a "half-life" equation was used to adjust for the constantly lessening water depths.

8. A sedimentation time frame of 1903 to 1978 provides estimated "half-life" projections of the larger lakes: Senachwine, 91 years; Billsbach, 63; Upper Peoria, 82; Beebe, 127; Grand Island lakes, 72; Meredosia, 119; and Swan, 119. However, a more current time frame results in shorter "half-life" projections: Upper Peoria, 24 years, based upon the sedimentation rates of 1967 to 1976; Lake Chautauqua, 76 years, using the 1926 to 1950 sedimentation rate and 60 years with the 1950 to 1976 sedimentation rate; Meredosia, 93 years, using the 1956 to 1978 sedimentation rate.

9. Especially tragic is the short recreational life predicted for Upper Peoria Lake. As the largest and most intensively used lake for recreation in central Illinois, its loss will be the greatest of all.

10. Only a reduction in soil erosion will extend the life of Illinois Valley bottomland lakes. The only alternative is to convert some drainage and levee districts to flood storage and conservation and recreation use.

REFERENCES CITED

BELLROSE, FRANK C., RICHARD E. SPARKS, F. L. PAVEGLIO, JR., D. W. STEFFECK, R. C. THOMAS, R. A. WEAVER, and D. MOLL. 1977. Fish and wildlife habitat changes resulting from the construction of a nine-foot navigation channel in the Illinois Waterway from La Grange Lock and Dam upstream to Lockport Lock and Dam. U.S. Army Corps of Engineers District, Chicago. 150 p.

______, FRED L. PAVEGLIO, JR., and DONALD W. STEFFECK. 1979. Waterfowl populations and the changing environment of the Illinois River valley. Illinois Natural History Survey Bulletin 32:1–54.

BUTTS, T. A. 1974. Measurements of sediment oxygen demand characteristics of the upper Illinois waterway. Report of Investigation 76. Illinois State Water Survey, Urbana. 32 p.

DICKERSON, RAY C. 1971. Inventory of Illinois drainage and levee districts. Illinois Department of Business and Economic Development. 955 p.

GREENFIELD, R. E. 1925. Comparison of chemical and bacteriological examinations made on the Illinois River during a season of low and a season of high water—1923–1924. Illinois State Water Survey Bulletin 20:9–33.

HAVERA, S. P., F. C. BELLROSE, H. K. ARCHER, F. L. PAVEGLIO, JR., D. W. STEFFECK, K. S. LUBINSKI, R. E. SPARKS, W. U. BRIGHAM, L. COUTANT, S. WAITE, and D. MCCORMICK. 1980. Projected effects of increased diversion of Lake Michigan water on the environment of the Illinois River valley. U.S. Army Corps of Engineers, Chicago District. XXV + 550 p. + appendices.

ILLINOIS DIVISION OF WATERWAYS. 1956. Maps of Meredosia Bay.

______. 1969. Report for recreational development. Illinois River backwater areas. Appendix maps. 89 p.

KOFOID, C. A. 1903. Plankton studies. IV. The plankton of the Illinois River, 1894–1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. Illinois State Laboratory of Natural History Bulletin 6:95–629.

LEE, MING T. 1976. Sediment deposition of Lake Chautauqua, Havana, Illinois. Unpublished Xeroxed report.

______, and NANI G. BHOWMIK. 1979. Sediment transport in the Illinois River. Illinois State Water Survey Contract Report 218 prepared for the Illinois Division of Water Resources. 49 p.

______, and JOHN B. STALL. 1976. Sediment conditions in backwater lakes along the Illinois River. Illinois State Water Survey Contract Report 176. 73 p.

______, and ______. 1977. Sediment conditions in backwater lakes along the Illinois River—Phase 2. Illinois State Water Survey Contract Report 176. 63 p.

MILLS, HARLOW B., WILLIAM C. STARRETT, and FRANK C. BELLROSE. 1966. Man's effect on the fish and wildlife of the Illinois River. Illinois Natural History Survey Biological Notes 57. 24 p.

MULVIHILL, W. F., and L. D. CORNISH. 1929. Flood control report: an engineering study of the flood situation in the state of Illinois. Illinois Division of Waterways. 402 p.

RICHARDSON, ROBERT E. 1921. The small bottom and shore fauna of the middle and lower Illinois River and its connecting lakes, Chillicothe to Grafton: Its valuation; its sources of food supply; and its relation to the fishery. Illinois State Natural History Survey Bulletin 13:363–522.

SIMONS, D. B., R. M. LI, Y. H. CHEN, S. S. ELLIS, and T. P. CHANG. 1981. Investigation of effects of navigation traffic activities on hydrologic, hydraulic, and geomorphic characteristics. Working Paper 2 for Task D submitted to Upper Mississippi River Basin Commission.

SPARKS, RICHARD E., and WILLIAM C. STARRETT. 1975. An electrofishing survey of the Illinois River, 1959–1974. Illinois Natural History Survey Bulletin 31:317–380.

STARRETT, WILLIAM C. 1972. Man and the Illinois River. Pages 131–169 *in* R. T. Oglesby, C. A. Carlson, and J. A. McCann, eds., River ecology and man. Academic Press, Inc., New York.

STEFFECK, D. W., F. L. PAVEGLIO, JR., F. C. BELLROSE, and R. E. SPARKS. 1980. Effects of decreasing water depths on the sedimentation rate of Illinois River bottomland lakes. Water Resources Bulletin 16:553–555.

UPPER MISSISSIPPI RIVER COMPREHENSIVE BASIN STUDY COORDINATING COMMITTEE. 1970. Upper Mississippi River comprehensive basin study. Vol. 3. Appendix G, Fluvial sediment.

U.S. ARMY CORPS OF ENGINEERS. 1933. Illinois and Des Plaines Rivers from mouth of the Illinois River to Lockport, Illinois. U.S. Engineers Office, Chicago, Illinois.

______. 1965. Illinois Waterway, Peoria Pool 1965 soundings. Peoria Area Office.

______. 1976. Illinois Waterway, Peoria Pool 1976 soundings. Peoria Area Office.

______. 1979. Quantitative report. Upper Mississippi and lower Illinois rivers. Pools 24, 25, and 26. Terrestrial and aquatic land use and habitat change as a result of the nine-foot channel project. St. Louis District.

U.S. DEPARTMENT OF COMMERCE AND LABOR. 1911. Special Reports. Fisheries of the United States 1908. Government Printing Office, Washington, D.C. 324 p.

VANONI, V. A., ed. 1975. Sedimentation engineering. American Society of Civil Engineers Manuals and Reports on Engineering Practice 54. 745 p.

WALRAVEN, W. B. 1950. Potential conservation areas along the Illinois River as a part of flood protection. Illinois Department of Conservation. 80 p.

WOERMANN, J. W. 1902–1904. Map of the secondary triangulation system of the Illinois and Des Plaines Rivers from Chicago, Illinois, to the mouth of the Illinois River. Corps of Engineers, Chicago Office, U.S. Army.

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